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REPORT OF THE CHIEF OF THE BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE, AGRICULTURAL RESEARCH ADMINISTRATION, 1943

United States Department of Agriculture,
Washington, D. C., September 15, 1943.

Dr. E. C. Auchter,
Agricultural Research Administrator.

Dear Dr. Auchter: I submit herewith a report of the work of the Bureau of Entomology and Plant Quarantine for the fiscal year ended June 30, 1943.

Sincerely yours,

P. N. Annand, *Chief.*

Ever since the entry of the United States into the war, the work program of this Bureau has been subject to constant study and frequent revision with the objective of focusing it on those projects most intimately related to the war. The Bureau's regulatory work is designed to prevent the entry into this country and the spread within the country of insect pests and plant diseases injurious to agriculture. Its control activities are aimed at the control, eradication, and prevention of spread of insect pests and plant diseases which are menaces of economic importance. Its research is designed to develop the best methods of applying control and eradication efforts. All these activities have as their primary aim the protection of food crops and other important national resources. Owing to the war-induced scarcity of materials widely used in insecticides, particular emphasis has been placed on research to develop substitutes and to determine the possibility of reducing the recommended dosages of standard insecticides.

FRUIT INSECT INVESTIGATIONS

CODLING MOTH CONTROL WITH INSECTICIDES IMPROVED

Phenothiazine of extremely fine particle size continued to give good control of the codling moth in field tests at several localities. In the Pacific Northwest the development of improved stickers resulted in control with 1 pound of phenothiazine equal to that previously obtained with 2 pounds. Satisfactory control was also obtained with mixtures of phenothiazine and lead arsenate, each used in half the usual strength. Also it was found that phenothiazine could be substituted for lead arsenate in the early cover sprays. These variations in its use, however, did not materially change its unsatisfactory effect on the size and color of the fruit.

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The Vincennes, Ind., laboratory has obtained further favorable results with Mississippi bentonites, which combine well with nicotine to form nicotine bentonite. The new spray leaves comparatively little visible residue and may be used with mineral oil, whereas nicotine bentonite made from Wyoming bentonite leaves considerable visible residue and its application involves the use of soybean oil, at present a scarce material.

A complex organic compound, 2,2-bis(parachlorophenyl)1,1,1-trichloroethane, for convenience referred to as DDT, has been found to be very poisonous to the codling moth, both in laboratory tests at Beltsville, Md., and in laboratory-field tests in Vincennes, Ind.

Synthetic cryolite was inferior to lead arsenate in controlling the codling moth in the Hudson Valley and caused severe cracking of the fruit.

In a large-scale orchard test at Yakima, Wash., 4,6-dinitroorthocresol with stove oil and a penetrant, sprayed on the trunks and scaffold limbs of apple trees to destroy overwintering codling moth worms in cocoons, resulted in a cleaner crop than where no such treatment was used, or even where the trees were scraped and banded.

COMSTOCK MEALYBUG REDUCED BY NATURAL ENEMIES

In 1942 many new infestations and considerable damage to apple trees by the Comstock mealybug were reported from northern Virginia and Connecticut; several orchards in Ohio and New Jersey also suffered losses. In the spring of 1943 this mealybug was very scarce in the older infested areas of Virginia, West Virginia, and Ohio, owing in part to the activities of parasites originally brought in from Japan and in part to the work of a native fungus disease during a prolonged period of rainfall in the late summer and fall.

PROPYLENE DICHLORIDE EFFECTIVE AGAINST THE PEACHTREE BORER

At the Fort Valley, Ga., laboratory propylene dichloride has been found to be more effective than ethylene dichloride for peachtree borer control but somewhat more likely to cause injury to the trees. Because of the lower strength needed for control, however, the margin of safety seems to be a little wider than with ethylene dichloride.

ORIENTAL FRUIT MOTH PARASITES DISTRIBUTED TO NEW AREAS

Methods of breeding the oriental fruit moth parasite *Macrocentrus ancylivorus* Roh. were further improved, and in the spring of 1943 it was distributed to a number of localities where the moth has been causing injury and the parasite has appeared to be absent. Similar stock was also furnished for an extensive program of parasite utilization to be undertaken by California State agencies in their effort to suppress this moth, found in southern California for the first time in the fall of 1942.

INSECTS TESTED AS POSSIBLE CARRIERS OF PEACH VIRUS DISEASES

Approximately 1,600 tests were started during the year to determine the possible part played by various suspect insects in the transmission of peach virus diseases, including peach mosaic, phony peach, peach

rosette, and the western "X" disease. Additional vectors of peach yellows were also sought. Survey collections to locate other insect vectors of the various diseases were greatly reduced.

DRIED-FRUIT PACKAGES TESTED FOR INSECTPROOFNESS

At Fresno, Calif., special attention is being given to the control of insects that attack dried fruits intended for military use. As a basis for work on the insectproof qualities of dried-fruit packages, studies have been made to determine the size of opening that will permit the entrance of various insects. Newly hatched larvae of the Indian-meal moth and the confused flour beetle were able to enter a crevice 0.12 mm. (about 0.005 inch) wide. Larvae of the saw-toothed grain beetle gained entrance to food through a crevice 0.16 mm. wide. Tests have been made of the insectproofness of several types of containers, and arrangements are being made for more extensive tests.

Dipping for 6 seconds in boiling water has been found to kill insects in certain dried fruits. This method would be especially valuable in dealing with infestation in small lots of home-dried fruit.

GRAPE BERRY MOTH DAMAGE REDUCED BY CULTURAL METHODS

Experiments with cultural control carried on near Sandusky, Ohio, indicate that it is possible to reduce grape berry moth infestation by approximately 50 percent in a single season. The most effective practice seems to be to plow up the soil in a ridge under the vines in the fall to expose the berry moth cocoons on the surface of the soil during the winter, and to cover the cocoons in the spring by hoeing out the ridges under the vines with a power hoe and then plowing the centers. Wet weather, however, sometimes interferes with the effective use of cultural methods in heavy soils.

CALIFORNIA RED SCALE POPULATIONS INCLUDE RESISTANT AND NONRESISTANT STRAINS

It has been determined that the resistance of California red scale populations to fumigation with hydrocyanic acid varies from grove to grove. Many tests have supported the assumption that this variation is due to the fact that the different populations consist of mixtures of the two strains in varying proportions and that repeated fumigations remove most of the nonresistant individuals, leaving mostly pure resistant stocks.

FUMIGATION OF CALIFORNIA RED SCALE IMPROVED

Improvements have been made in the blower-type cyanide applicator for the fumigation of citrus trees against the California red scale. It has also been found that a canvas tent doubly treated with a plastic will retain the gas practically as well as a gastight box. Laboratory tests showed that, for scales exposed to sublethal concentrations of cyanide to produce protective stupefaction, the kill was dependent on the average concentration, while in the absence of protective stupefaction the best kills were obtained when the concentration was high at first and then decreased rapidly.

CITRUS THRIPS DEVELOP IMMUNITY TO TARTAR EMETIC

Investigations of reports that control of the citrus thrips with tartar emetic spray was not being obtained in certain lemon groves in southern California disclosed that the thrips in these particular groves, where control with tartar emetic had been adequate for 3 or more years, appear to have developed immunity to that material.

FIGHT AGAINST THE JAPANESE BEETLE CONTINUES

By the close of the calendar year 1942 the cooperative program of distribution of the milky disease of Japanese beetle grubs had resulted in the treatment of more than 45,000 sites in 121 counties in 12 States, and in addition the Bureau had treated 6,211 acres of turf on 91 Government-owned reservations in 8 States and the District of Columbia.

Of 113 materials and combinations tested in the field as baits in Japanese beetle traps, anethole derived from pine oil, and satisfying the requirements of the National Formulary, and pimento leaf oil, both of domestic origin, show the greatest promise as substitutes for geraniol and eugenol, of oriental origin and now very scarce.

Late in June 1943 favorable preliminary results were obtained against adult beetles with the organic compound DDT. This material seems to be both highly poisonous and repellent to the Japanese beetle.

PEAR PSYLLA BEING SUPPRESSED IN THE NORTHWEST

The 1942 pear psylla survey in the Pacific Northwest revealed minor extensions of the infested area, but the insect did not reappear in certain other areas formerly known to be infested. The intensive spray program carried on in the last few years appears to have eliminated the insect completely from a number of previously infested orchards. There was a late flare-up of infestation in Okanogan County, Wash., in the fall of 1942, and the pest was discovered in British Columbia in 1942 for the first time. In the spring of 1943 it was found that treating suspected trees with nicotine dust and the use of sticky boards to trap psylla adults in trees may increase the effectiveness of the scouting.

Late in the winter, in cooperation with growers, a dormant spray was applied to all pear trees within the infested area. In the summer spray applications, ranging in number from 1 to 9, special attention was given to areas most likely to permit spread into the main commercial pear-producing areas. In 1942 a total of 2,434,098 gallons of spray were applied to approximately 432,000 trees, stumps, and regrowth on 38,853 properties in 10 Washington counties, and 835,666 gallons were applied to approximately 118,500 trees, etc., on 18,176 properties in 5 counties of Idaho. In addition, the growers applied 3,186,740 gallons of spray to approximately 207,500 trees, stumps, and regrowth in the 2 States.

In order to safeguard the work done in the Okanogan Valley in Washington, this Bureau has cooperated with the Canadian authorities, and in the early summer of 1943 made two applications of spray to about 40,000 pear trees in the lower Okanogan Valley of British Columbia.

Ammonium sulfamate proved to be the safest, most effective, and most easily applied material tried at the Yakima, Wash., laboratory

to kill stumps of pear trees in connection with the pear psylla control program. It is also very effective as a spray on sucker growth and does not have the sterilizing effect on the soil that other materials have.

HALL SCALE CONTROL PROGRESSING

The program for eradication of the Hall scale (*Lepidosaphes halli* Green) near Chico, Calif., has been continued. The survey in 1942 revealed the existence of two additional infestations, both of them within 2½ miles of Chico and within 6 miles of the original infestation. Scouting, with negative results, has also been done in other localities, where plants are known to have been received from the originally infested Plant Introduction Garden. Two applications of oil sprays were made to the known infestations during the summer of 1942 and one each during the winter of 1942–43 and the early summer of 1943. Experimental fumigation has given favorable results.

NEW INFESTATIONS OF PARLATORIA CHINENSIS FOUND

A continuation of the survey to determine the distribution of the scale insect *Parlatoria chinensis* (Marl.) in St. Louis, Mo., indicated that this pest may now be rather generally distributed over much of the city. Several of the outermost infestations were found to be the result of movement of plants from the part of the city originally infested. During the late winter and spring of 1943, infestations of this insect were found by the Florida State Plant Board in three southern Florida counties, occurring only on several different species of *Ficus*.

Further laboratory and field tests at St. Louis indicated that effective commercial control of this scale insect can be obtained with emulsions containing 3 or 4 percent of lubricating oil applied during the dormant or delayed-dormant season. Paraffin-base oils appear superior to naphthene-base oils, and the addition of cube resins or dinitroorthocyclohexylphenol to low concentrations of oil emulsions increased the efficiency markedly. Quick-breaking types of oil emulsions were more effective than more stable types.

FRUITFLY INVESTIGATIONS

In Mexico the development of a method for the vapor-heat sterilization of mangoes is being completed. Studies show that in applying the method to thin-skinned tropical fruits preconditioning to avoid injury to the fruit will be required. Lure formulas that repel moths but attract fruitflies have been developed and are under field test. The efficiency of the soap lure formula in Hawaii has been increased. Cooperative work with other agencies has included the collection and shipment of blackfly parasites to Mexico, work in the Canal Zone on termite resistance, and cooperation with Hawaiian authorities in food production and the protection of stored foods against insects.

INVESTIGATIONS OF INSECTS AFFECTING FOREST AND SHADE TREES

TERMITE RESEARCH AIDS WAR PROJECTS

Engineers, architects, and contractors affiliated with local, State, and Federal agencies concerned with housing and other war construc-

tion projects were advised on measures to be taken to afford adequate protection against termite damage. In many cases it was necessary to make detailed studies of building plans, or of construction under way or completed, before suggesting preventive or corrective measures. This work has resulted in marked improvement in the design and construction of Federal housing projects, particularly with respect to the design of steps and entrance platforms, subfloor clearance, ventilation, soil drainage, and general sanitation in the use of wood. In spite of this general improvement, however, large numbers of federally owned buildings are infested or will become infested by termites and will require treatment to prevent excessive damage. Further research is needed to develop cheaper and more effective control methods, especially for use in low-cost housing projects. Studies of soil poisons have been expanded during the year in the belief that their use will offer the most practical means of control in these cheaper buildings.

Information on the natural resistance of various woods to damage by termites and to decay was furnished in connection with construction of the Inter-American Highway, where it is necessary to use locally obtained timbers instead of steel and concrete for bridges. The results of previous limited tests with Central American woods were made available, and new tests were initiated, in cooperation with the War Department; the Forest Service; and the Bureau of Plant Industry, Soils, and Agricultural Engineering, in the use of soil poisons and the injection of chemicals into the sap stream of tropical woods, on Barro Colorado Island, Canal Zone. These tests are designed to give preliminary results in a few months' time.

Numerous inquiries from military and other sources late in 1942 indicated that termites were damaging clothing, tenting, cartridge belts, sand bags, and various other types of fabrics used under tropical conditions. Arrangements were made for cooperative tests with the Bureau of Human Nutrition and Home Economics; the Bureau of Plant Industry, Soils, and Agricultural Engineering; and the Southern Regional Research Laboratory of the Bureau of Agricultural and Industrial Chemistry. Fabrics treated with chemicals that have proved effective against mildew and decay are being given special attention. Results thus far show that several of the copper compounds and certain proprietary materials will give reasonably good protection.

PREVENTION OF INSECT DAMAGE TO SITKA SPRUCE LOGS FOR AIRPLANE CONSTRUCTION

Owing to a scarcity of high-grade Sitka spruce suitable for airplanes, damage by ambrosia beetles to the sapwood of valuable logs must be prevented. Studies on this problem have shown the period of time within which logs must be removed from the woods to avoid attack, and the maximum time allowable before serious damage results. Bringing this information to the attention of loggers getting out this war material has increased the amount of clear lumber available for airplane stock.

EFFECT OF FOREST INSECTS ON THE CAMOUFLAGE PROGRAM

The camouflage program of some Army camps has been threatened as a result of bark beetle and borer attacks in trees. The trees had

been damaged, some severely, at the time buildings were erected. In some instances inspections revealed that the insect species infesting the trees would not kill them if precautions were taken against further mechanical injury. On the basis of advice from this Bureau, Army officials established tree-maintenance rules, which have prevented the destruction of hundreds of trees considered vital to the camouflage program.

The Army has also asked for suggestions in the control of defoliating insects. Adequate control measures can be applied, but where surrounding forest areas are also affected it is possible that treatment of only the camouflage area might make that area more conspicuous. Careful study of each area is therefore necessary before control measures are applied.

COOPERATIVE RESEARCH ON THE GYPSY MOTH PROBLEM

A closely coordinated program of research has been developed between the Division of Forest Insect Investigations, the Division of Gypsy and Brown-Tail Moths Control, and agencies in the affected States. The broad objectives of this program are to obtain the fundamental information upon which the development and improvement of methods of control may be based. The program is divided into four projects—ecological investigations, trapping methods, insecticidal investigations, and silvicultural control.

The ecological investigations are designed to determine the environmental conditions under which the gypsy moth may frequently increase to outbreak proportions and those under which it may be held in check perennially by natural factors. This information may be used as a basis for determining where and what type of control work should be conducted in New England and the areas where emphasis should be placed in combating the insect in New York and Pennsylvania.

Studies are under way to improve the trapping methods now being used to detect the presence of the gypsy moth in outlying areas where an attempt is being made to prevent the spread of the insect. Better traps and attractant materials are being developed, which should reduce the cost of surveys and make them more effective.

Small-scale laboratory tests are being conducted with a large number of nonarsenical insecticides, and woodland plots are being treated with the most promising ones by means of a power sprayer. These tests have shown cryolite to be the most effective of the nonarsenicals that are available in quantity. Cryolite has an advantage over lead arsenate in being less toxic to man and domestic animals. Tests under way suggest that, in dosages used against the gypsy moth, it may not be harmful to livestock.

The reduction in the proportion of highly favored trees and the encouragement and introduction of unfavored species create conditions in the forest unfavorable to the insect. Every effort is being made during the war period to encourage the cutting of low-grade highly favored hardwoods as a means of increasing the production of fuel wood and at the same time carrying out the objectives of silvicultural control.

WESTERN BARK BEETLE SITUATION

The annual bark beetle surveys of western pine forests, conducted in cooperation with the Forest Service, the National Park Service, the Office of Indian Affairs, and private timber owners, revealed a greatly improved condition in 1942 in respect to the total amount of timber destroyed by these beetles as contrasted with previous years. From a high loss of 3.3 billion board feet in 1932, insect-caused destruction of ponderosa pine in California, Oregon, and Washington has declined to an estimated loss of less than 750 million board feet in 1942, and this gross loss is largely offset by current growth in these virgin pine forests. A similar reduction in loss has occurred throughout most of the Rocky Mountain region. This reduction has been due in large measure to natural causes supplemented by increased efforts to make forests more resistant and to control outbreaks before they have gained momentum. That such a favorable situation exists is fortunate because of the demand for wood products from some of the commercial areas where control work has saved much valuable timber, and because of the lack of labor with which to carry out a large control program at the present time.

INSECT ENEMIES OF RUBBER-PRODUCING PLANTS

Test plantings of the rubber-producing plants goldenrod and koksaghyz were found to be infested with thrips, leafhoppers, and white grubs. These infestations indicate the possibility of serious damage if these plants are ever grown on a large scale.

Considerable attention was given to insects attacking guayule nurseries and plantations in California and Texas. Such insects include grasshoppers, tenebrionid ground beetles, wireworms, ants, termites, lacebugs, leafhoppers, and *Lygus* bugs. In California grasshoppers threatened 4,000 acres of guayule in the Wasco district near Bakersfield, 600 acres at Arbuckle, and more than 200 acres at Patterson. Much loss would have resulted if control measures had not been applied. Tenebrionid ground beetles affecting 200 acres of seedling stock at the Mission, Calif., nursery were controlled with poisoned-bran mash. The work to date indicates that insect damage can be held below the critical point by prompt adaptation and application of measures known to control similar insects on other crops.

CEREAL AND FORAGE INSECT INVESTIGATIONS

WHEAT RESISTANT TO HESSIAN FLY RELEASED IN CALIFORNIA

As a result of cooperative work with the Bureau of Plant Industry, Soils, and Agricultural Engineering and the California Agricultural Experiment Station, small quantities of a club-type wheat, Poso 42, into which a high degree of resistance to the hessian fly as well as desirable agronomic qualities has been bred, were released to California growers in 1942. Culminating 13 years of intensive breeding under this cooperative program, another variety, Big Club 43, possessing resistance to stem rust, bunt, and root rot as well as to the hessian fly, is being increased for immediate release in California. Other new varieties having high resistance to the hessian fly are well advanced toward release in Kansas and Indiana.

WIDER USE OF OIL TREATMENT AND RESISTANT VARIETIES OF CORN FOR EARWORM CONTROL

A study made in the Boise Valley of Idaho demonstrated that a single treatment of the ears with pyrethrum extract in mineral oil will protect sweet corn grown for seed against the corn earworm, even though this corn is exposed to infestation much longer than market green corn.

In the search for substitutes for pyrethrum in earworm oil, styrene dibromide was found to be effective and to leave no detectable odor or taste on the treated ears.

Resistance to the earworm and other insects in certain lines of field and sweet corn has been found in cooperative Federal and State investigations at Urbana, Ill., and Lafayette, Ind. Similar cooperative work has been started at State College, Miss., as a part of a new project on the development of corn hybrids for the Southeastern States.

VETCH BRUCHID EXTENDS ITS TERRITORY

Partial results of a general survey, now in progress, revealed the presence of the vetch bruchid in the limited areas of northern Georgia, Alabama, and Mississippi where hairy vetch seed is grown, and confirmed its occurrence in northwestern Idaho and eastern Washington, first reported last year. It has greatly reduced the production of hairy vetch seed in the South Atlantic States and has become seriously injurious in the Willamette Valley of Oregon.

Since rotenone dust, which has been found to give fair control, has become scarce, other insecticides are being tested in an effort to find a substitute. A sweetened poison-bait spray has shown some promise in preliminary experiments.

PROGRESS IN COMBATING OTHER FORAGE-CROP PESTS

Selections of alfalfa resistant to the pea aphid and suited to conditions in California and Kansas have been isolated and further tested. Additional information has been obtained on the anatomical characters responsible for this resistance.

Cage and field observations showed that *Lygus* bugs and certain other sucking bugs materially reduce the yield of alfalfa hay as well as seed in the arid Southwest, and may be an important factor contributing to losses in stands of alfalfa.

The sweetclover weevil has recently become injurious in the North Central States. The beetles feed on the leaves and tender tips of the new growth in the spring, often completely defoliating it and killing seedling plants. In preliminary experiments good control was obtained with a dust containing dinitroorthocyclohexylphenol and sulfur, although with some burning of the foliage.

GRASSHOPPER POPULATIONS ON DECLINE

The downward trend in grasshopper populations which began in 1939 continued during 1942. Observations made on representative study areas indicated that the population of nymphs, or immature hoppers, was 54 percent lower in 1942 than the 1936–41 average. Adult populations were 30 percent less and egg populations 47 percent less than the average for the preceding 6 years.

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SUBSTITUTES FOR BRAN AND SAWDUST IN BAITS AND METHODS OF CONSERVING BAITS

Cottonseed hulls with mill-run bran (3:1) or with whole-wheat flour (15:1 and 20:1) and either new or old sawdust substituted for cottonseed hulls gave equally good results in field trials against grasshoppers. Similar trials indicated that steam-rolled wheat, either moistened or oiled, can be used with excellent results in place of standard bran in Mormon cricket baits. These results open up the possibility of utilizing cheap, low-grade flour or wheat in grasshopper and Mormon cricket control in place of high-priced bran needed for stock feed.

Research on Mormon cricket baits demonstrated that savings can be made by adjusting the rate of distribution in accordance with the density of the populations. Where there were 15 or more crickets per square yard continuous baiting at the rate of 10 pounds of bait per acre was required; where there were from 10 to 15 per square yard alternate baited and unbaited strips 30 feet wide were sufficient; and where there were only 6 to 10 per square yard the width of the unbaited strips could be increased to 60 feet.

PLANS FOR MORMON CRICKET CONTROL THROUGH PREVENTION OF OUTBREAKS

A study of four major outbreaks in past years has shown that extensive losses to crops and large sums spent for control resulted from original small infestations in mountainous areas. Had timely application of modern control methods been possible, these outbreaks and losses could have been prevented at a small fraction of the expenditures actually made. Plans are being made to keep watch over these and other outbreak centers that may be located, with the cooperation of ranchers and stockmen, with a view to preventing future outbreaks through local control measures.

CULTURAL CONTROL OF THE WHITE-FRINGED BEETLE MAY BE PRACTICABLE

Damage by the white-fringed beetle to field and garden crops in the Florala, Ala., area was greater in the early part of 1943 than in any year since 1937. During the last 5 years the larvae were most abundant in fields that had contained peanuts or had been in corn with an intercrop. Cage tests showed that larval survival is much lower in the heavy soils near New Orleans than in the lighter soils in other parts of the infested area, and that, although survival varies with the supply of organic matter, the larvae can live a long time in soil containing practically none. Larval damage to crops was less where heavy vegetation had been plowed under than in more barren soil, apparently because the larvae feed to a considerable extent on the dead and decaying plant material rather than on the living plants. This fact may be of practical value in cultural control. On the basis of field-plot studies for the last 6 years, crop rotations conducive to reductions in beetle populations and damage have been tentatively recommended.

PROCEDURES FOR FUMIGATING STORED GRAINS AND CEREALS IMPROVED

From laboratory and field studies an economical procedure has been formulated for preventing insect damage to wheat in long-time

storage in farm-type bins—by fumigation if needed when first put in storage, periodical inspection, and fumigation each fall.

Experiments with hydrocyanic acid, methyl bromide, and other commonly recommended fumigants, applied in standard concentrations, indicated that none were harmful to the vitamin B_1 (thiamine chloride) in enriched flour.

That caution should be used in applying some types of fumigants to grain of high moisture content was shown by recent investigations. Methyl bromide, chloropicrin, and carbon disulfide, when applied at ordinarily recommended concentrations, materially reduced the germination of wheat having a moisture content above 12 percent.

In an experiment the insect population in a flour mill was kept down by a general fumigation followed by fumigation of conveyors every 3 weeks and weekly removal of stock from elevator boots.

Freight cars were successfully fumigated with methyl bromide, at a dosage of 6 pounds per car, for control of hidden flour-infesting insects prior to loading with flour. Cars loaded with flour were also successfully fumigated with methyl bromide to kill stored-flour insects flying into them in large numbers while they were being loaded.

INCREASED CORN BORER INFESTATIONS STIMULATE RESEARCH ON CONTROL

Surveys indicated that in 1942 the European corn borer caused losses of field and sweet corn totaling more than $17,000,000. These losses were considerably greater than in any previous year since the discovery of the borer in the United States. Its westward dispersal was also the most extensive observed in recent years. The borer was found throughout Illinois, completely across southern Wisconsin, and for the first time in eastern Iowa and northeastern Missouri. Recent reports from eastern Iowa indicate that it multiplied rapidly there in 1943. In June 1943 a substation was established at Burlington, Iowa, to study its biology and control in this newly infested area.

Studies in evaluation of factors affecting corn borer abundance indicated that, when fields containing infested corn residues were plowed and planted to cultivated crops other than corn, only about one-fourteenth as many borers survived in them as in fields where uncultivated crops followed corn. These results point to the desirability of following corn with a cultivated rather than noncultivated crop in rotation, as a corn borer control measure.

In commercial-scale trials of a derris spray at Toledo, Ohio, and of derris spray and dual-fixed nicotine dust at New Haven, Conn., at costs of $19 to $24 per acre, these treatments showed a net profit of about $400 per acre from increased yield and reduction in borer infestation of early sweet corn.

Tests during 1940, 1941, and 1942 to determine the possibility of increasing borer resistance in sweet corn by individual plant selection within inbred lines already homozygous for other characters showed consistent differences in infestation in the segregates. The results suggest that these differences are genetic and that a limited improvement in borer resistance in corn may be attained by this means. This phase of the general program for production of borer-resistant lines merits attention in this time of need for quick results. If fairly resistant selections can be discovered, they may be of immediate commercial value because their desirable agronomic characters will already have been fixed.

Considerable promise is indicated that imported parasites may become an important factor in the natural control of the corn borer. Four species, one fly and three wasps, have already become abundant in certain environments, and a total parasitization as high as 40 percent has been found in sizable areas of the Northeastern States. Colonization of these parasites in new localities is being continued.

SUGARCANE BORER CONTROLLABLE WITH CRYOLITE DUST

In 1942 it was estimated that the sugarcane borer reduced the yield of sugar in Louisiana by 226 million pounds. Field experiments culminating in 1942 showed that this borer may be controlled profitably by four applications of cryolite dust at weekly intervals during the egg-hatching period of the first- or second-generation borers. In 1943 this treatment was applied by ground equipment or airplane to about 7,000 acres of sugarcane.

PROGRESS IN DEVELOPMENT OF BORER-RESISTANT VARIETIES OF SUGARCANE AND PARASITE DISSEMINATION

Of 4,582 seedling varieties of sugarcane tested during the last 6 years, 4 gave progeny resistant to the borer. Three noncommercial varieties have been selected because of their consistently low infestation for use as parental material in breeding for resistance. In 1 test involving 49 varieties, 4 of them had less than 5 percent and 12 had less than 10 percent of the joints bored, when the average for the control variety, Co. 281, was 44 percent.

The borer infestation in 1942 was much lower than usual in southern Florida, apparently as a result of heavy parasitization in 1941 by the Cuban fly (*Lixophaga diatraeae* Towns.), the Amazon fly (*Metagonistylum minense* Towns.), and the hymenopteron *Bassus stigmaterus* Cress.—all introduced species. At Fellsmere in the summer of 1941 about 68 percent of the borers were parasitized.

SUGARCANE MITE APPARENTLY ERADICATED FROM FLORIDA

Intensive efforts to eradicate a local infestation of the West Indian sugarcane mite (*Tarsonemus bancrofti* Michael) at Canal Point, Fla., by the destruction or hot-water treatment of infested cane have apparently been successful. This was the only infestation known in the United States.

TRUCK CROP AND GARDEN INSECT INVESTIGATIONS

As the war continues, the control of insects that destroy vegetables and carry plant diseases to these crops assumes increased importance. The shortage of insecticides, particularly those containing pyrethrum and rotenone, together with the increases in the acreage of peas, beans, potatoes, and tomatoes, emphasizes the necessity of husbanding the limited supplies of materials now available and of developing substitutes. In addition to enlarged commercial plantings, the Nation's Victory Gardens have created a further demand for insecticides accompanied by information on garden-pest control. Contributions toward filling this demand have been made through mimeographed material, the radio, and the press, as well as through personal contacts by men in the field laboratories.

In connection with the allocation of rotenone and pyrethrum, data have been furnished on the current needs and usages of these restricted insecticides from the standpoint of their effectiveness against specific pests and the importance of the crops affected. In addition, surveys have been made to determine the regional abundance of some common pests as a means of having the proper insecticide readily available.

ROTENONE AND PYRETHRUM EXTENDERS STUDIED

The research program on vegetable insects has been guided by the necessity of husbanding insecticides and of developing materials to supplement the supplies that are scarce or are classified as critical war materials.

Efforts to extend the efficacy of rotenone and pyrethrum have shown that nicotine in combination with rotenone and sulfur is useful against the pea aphid, a dust mixture containing 0.375 percent of rotenone, with 1.7 percent of nicotine and 10 percent of sulfur, being as useful as a mixture containing 0.75 percent of rotenone. This nicotine-rotenone-sulfur combination was first shown to control the pea aphid by workers at the University of Wisconsin, and during the past season it has been used commercially with success. This combination, however, has not proved effective against cabbage caterpillars. The addition of nicotine to pyrethrum dust mixtures improved them as a remedy for the diamondback moth.

Experimentation with carriers and diluents shows that pyrophyllite increases the efficiency of rotenone dust mixtures and that in general the talcs are superior to the clays.

The organic thiocyanates were ineffective against the Mexican bean beetle when used alone and did not enhance the effectiveness of rotenone dust mixtures.

Investigations on methods of blending rotenone dust mixtures led to the conclusion that their effectiveness depends upon the chemical and physical qualities of the ground derris root, varying directly with its rotenone content and with the quantity of ground root applied to a given unit and inversely with the particle size.

NEW REMEDIES FOR VARIOUS PESTS

In collaboration with commercial and State agencies, a large array of new materials and combinations of materials have been tested for their insecticidal value. This work shows that as an emergency measure a dinitro compound may be substituted for pyrethrum in the control of the potato leafhopper on potatoes and beans, that a spray of sodium fluosilicate and sugar may supplement rotenone dust to control the pea weevil on Austrian peas, and that basic copper arsenate, limited supplies of which are available, is as effective as calcium arsenate against the tomato fruitworm, the Mexican bean beetle, and the Colorado potato beetle. Micronized phenothiazine gave sufficient control of the Mexican bean beetle to warrant further testing.

Although dusting with a pyrethrum-sulfur mixture was found to be the most effective method of combating plant bugs that feed on the seed pods of sugar beets, sulfur alone gave satisfactory control under conditions obtaining in Arizona. Since pyrethrum is becom-

ing increasingly scarce and is an important war material and sulfur is fairly cheap, the use of sulfur may prove practical for control of these plant bugs. Large-scale control operations against these plant bugs were carried on in Oregon and Utah, in cooperation with growers.

In a search for substitutes for lead arsenate for the control of the tobacco flea beetle and hornworms, two new materials, phthalonitrile and 2-fluorylamine, proved to be the most promising. No substitute for rotenone has been found for the control of flea beetles on shade-grown tobacco in Florida. Pyrethrum, if available, could be used against the potato flea beetle, which attacks tobacco in the Connecticut River Valley, but it will not control the tobacco flea beetle, which attacks the crop in the Florida area.

SPRAY SCHEDULES FOR POTATO FLEA BEETLES AND APHIDS

Investigations on flea beetles in the Yakima Valley, Wash., show that six or seven applications of calcium arsenate or cryolite at regular intervals are necessary to protect the potato tubers from feeding and grub damage. Although the cost of such treatments might not be economical under normal conditions, it is considered to be permissible as a wartime measure to protect the crop and produce maximum yields. Damage may also be lessened by improving drainage and decreasing the application of irrigation water combined with elimination of the practice of planting small acreages of potatoes at intervals throughout the season.

Work on aphids in Maine has shown that aphid infestations can be greatly reduced by applications of rotenone-soybean oil and nicotine-rotenone sprays.

In tests near Walla Walla, Wash., there was little difference in the kill of wireworms from naphthalene applied at rates of 200, 600, and 800 pounds per acre. A comparatively new material, known chemically as 1,1-dichloro-1-nitroethane, showed considerable promise and may prove to be useful in control of wireworms in commercial acreages.

WIREWORM POPULATIONS AFFECTED BY COVER CROPS

Studies on the relation of cover crops to wireworm populations in California indicate that barley, fenugreek, and mustard are favored for egg deposition in the spring, whereas lands planted to sweetclover are unattractive to adult wireworms. Lima beans planted in sweetclover fields therefore escape injury from wireworms.

RUSSET MITE CONTROLLED WITH SULFUR

The tomato russet mite (*Phyllocoptes destructor* Keifer) caused extensive damage to tomatoes in California in 1942. During the season this mite spread from a small area in the San Joaquin Valley that was affected in 1941 to practically all the tomato-growing districts of California. Fortunately the pest can be controlled by the use of sulfur if the infestation is discovered in its incipiency. The pest is more difficult to control in the cooler tomato-growing areas than in the warmer districts.

COTTON INSECT INVESTIGATIONS

Insect damage is the principal obstacle to maintaining the high yield and grade of cotton needed for more than 11,000 military items and for supplying civilians with food, feed, and fiber. Part of the all-time high yield per acre for the United States in 1942 was directly attributable to the reduction of losses due to insects. With the cooperation of State and other agencies, surveys were made of insect damage to aid in distributing supplies of insecticides and dusting equipment to the areas where they were most needed. This assistance in distributing approximately 75 million pounds of calcium arsenate and large quantities of other insecticides according to the abundance of cotton insects was a direct contribution to the war effort. In a further effort to conserve critical materials, the research program was modified to give special emphasis to reduced dosages and longer intervals between applications of insecticides, substitutes for calcium arsenate, and cultural and other methods of control that do not require the use of insecticides.

BOLL WEEVIL

Despite a heavy carry-over of boll weevils, the reduction from full yield due to this insect in 1942 was estimated at 8 percent, or about half the loss reported for 1941. Increased yields were obtained in 10 of the States where the boll weevil is a major pest. Changes made in the recommendations—to delay dusting until 20 to 25 percent of the squares are infested and to dust at any time of day or night when the air is calm—resulted in better utilization of insecticides, dusting machinery, and labor.

In tests on reduced dosages diluents were added to the insecticides, since smaller poundages could not be applied with the available dusting machines. At Tallulah, La., a reduction of 47 percent in the dosage of calcium arsenate was followed by a 31-percent reduction in weevil control and 33-percent reduction in the yield of cotton. At Waco, Tex., no significant differences in yields were noted between the normal and reduced dosages of calcium arsenate and cryolite, partly because of the very light weevil damage in all plots.

On the light sandy soils at Florence, S. C., injury to the soil from reduced dosages of calcium arsenate diluted with sulfur was noticeably greater than from calcium arsenate diluted with lime or from normal dosages of undiluted calcium arsenate.

In cage tests cryolite, an abundant material, was only about half as toxic to the boll weevil as calcium arsenate. In field tests the toxicity of cryolite was not lowered by dilution in the same proportion as was that of calcium arsenate, probably because its dusting qualities were improved by the diluents and better plant coverage was obtained. Sodium fluosilicate was more toxic than cryolite, but less so than calcium arsenate. It had poor dusting qualities and injured the foliage. In plot tests at Florence the addition of a small percentage of soybean flour helped to overcome these objections, and further tests with several specially prepared sodium fluosilicates are in progress. The addition of nicotine or derris to calcium arsenate to control aphids did not significantly reduce its effectiveness against the boll weevil.

Experiments to find substitutes for the two to three million gallons of molasses used in mopping mixtures for the boll weevil showed that

sweets are not essential, and that cornstarch, wheat flour, wallpaper paste, or some of the clays, which thicken the mixture, are about as effective as molasses.

An educational program urging early-fall cutting of cotton stalks to starve boll weevils, and thus to reduce the carry-over, was inaugurated in cooperation with several private, State, and Federal agencies. Posters were displayed at gins, oil mills, and other public places, and thousands of circulars were distributed to growers.

Defoliation of cotton was another method tested for forcing weevils to enter hibernation in a starved condition. At Stoneville, Miss., dusting with 10 to 30 pounds of calcium cyanamide per acre by ground machines or airplanes caused complete shedding of the leaves and squares in 3 to 6 days. The cyanamide, a nitrogenous fertilizer, is largely recovered by the succeeding crop. Defoliation not only removes the food from boll weevils and prevents staining of lint by leafworms and aphids, but makes hand picking easier and improves by a full grade the lint picked by mechanical harvesters.

Picking up and destroying weevil-infested squares gave very little or no control.

COTTON APHIDS

Investigations were continued to determine the causes of heavy aphid populations following the use of insecticides against other insects, to find materials for use with other insecticides, to prevent the build-up of aphids, and to develop aphid-resistant strains of cotton. In confirmation of last year's results at State College, Miss., nitrogenous fertilizer applied at the time of planting caused an increase in aphid populations when the cotton was dusted with calcium arsenate, but not when the cotton was untreated.

Plant susceptibility to arsenical injury was found to be correlated with earliness, a character that has been highly developed in modern varieties for evasion of boll weevil damage. At Stoneville, Miss., dusting cotton with calcium arsenate early in the season reduced the height of the plants, the number of leaves, and the number of bolls reaching maturity. The injury to the plant from arsenicals and the heavy aphid populations following their use often cause reductions in yield that are greater than the gains from boll weevil or bollworm control.

In cotton lightly infested with boll weevils at Waco, Tex., plots dusted with calcium arsenate and allowed to develop heavy aphid infestations yielded from 164 to 243 pounds per acre less than the untreated checks, while plots dusted with calcium arsenate and nicotine to control both weevils and aphids showed an average gain of 222 pounds of seed cotton per care.

Tests were continued with several materials as substitutes for derris, which is not available for cotton because of war restrictions. In greenhouse tests at Waco, spraying cotton seedlings with cold-press cottonseed-oil soap stock and water 1:60 or hydraulic-press cottonseed-oil soap stock 1:30 gave about the same mortality of aphids as spraying with nicotine sulfate 1:800. In field tests hydraulic-press soap stock at 1:60 was more effective against aphids than calcium arsenate dust containing 0.5 percent of rotenone, 0.5 percent of rotenone plus 4 percent of Lethane, or 1 percent of nicotine, but less effective than a lime dust containing 3 percent of nicotine. None of

the thiocyanates and other synthetic organic materials tested as aphicides were effective, either when used alone or when added to derris or nicotine. Two percent of nicotine added to alternate applications of calcium arsenate and 1 percent of nicotine added to each application were about equally effective in preventing an increase in aphids, although neither was satisfactory under all conditions.

Progress in developing aphid-resistant strains of cotton is slow, because no plants immune to attack have been found for breeding stock. The correlation found between plant susceptibility to aphids and pilosity (hairiness) of the leaves may be associated with the retention of arsenic on the leaves, since hairy leaves hold arsenic longer than smooth leaves. Some of the strains of cotton developed at Stoneville, Miss., are now about 25 percent resistant to aphids. Several cotton breeders are sending their new strains to be tested for aphid resistance before offering them to the public.

In studies of alternate host plants, *Aphis gossypii* Glov. was collected at Tallulah, La., on 13 wild and cultivated plants during the winter and early spring before this species was taken on cotton on April 15. Three other species of aphids—*Aphis medicaginis* Koch, *Myzus persicae* (Sulz.), and *Macrosiphum solanifolii* (Ashm.)—were collected on cotton during May, but after the middle of June all aphids found on cotton were *A. gossypii*.

PINK BOLLWORM

In the lower Rio Grande Valley ecological studies to aid in the control of the pink bollworm received first consideration. The large overwintering population from the 1941 crop, together with favorable conditions for seasonal development, caused an increase in population and spread to new fields in 1942. The fact that most of the spread was due to moths migrating from early-maturing fields to late cotton emphasizes the importance of a uniform planting date in a given area. Moths from infested bolls collected in the field during August, September, and October 1942 started to emerge soon after collection. Emergence from larvae in the August-collected bolls was completed in the fall, while 9 percent of the larvae in September-collected bolls and 12 percent in October-collected bolls produced moths after February 1, 1943. More than three times as many worms survived the winter in bolls that were left on the soil surface as in bolls that were buried. These experiments clearly show the value of early field clean-up followed by cultural practices for pink bollworm control.

More pink bollworms were found in the secondary malvaceous host plants than in any previous year. Most of them were found late in the season after the cotton had matured, and the indications are that under some conditions this pest may be carried over from one crop to the next in the secondary hosts.

In the Big Bend area of Texas the infestation late in August was considerably higher in 1942 than in 1941. Floods from the Rio Grande over about half the cotton acreage near Presidio reduced the overwintering populations, although not so much as did the flood in 1938. The floods interfered with the variety tests, cultural-control experiments, and colonization of parasites. A total of 177,000 specimens of *Chelonus pectinophorae* Cush., an egg parasite received from Japan in 1940, were released in the fields during the season. Four shipments

of *Microbracon vulgaris* (Ashm.), consisting of 937 cocoons, were received from Brazil, but laboratory rearing of this species has been less successful than with other species of *Microbracon*.

BOLLWORM INVESTIGATIONS

Bollworm damage was less than in 1941. Survival of overwintering larvae in hibernation cages at Waco, Tex., was 0.4 percent as compared with 23 percent last year. Studies of the failure of eggs to hatch confirmed previous results that low humidity is not so important as high temperature. Several predators, which destroyed a large percentage of the eggs and small larvae when aphids were not present, were less efficient when aphids were abundant. In tests with insecticides large dosages were necessary for good control.

The gains from dusting with calcium arsenate ranged from 225 pounds of seed cotton per acre when 8 pounds of the dust was used to 397 when 16 pounds was dusted per acre. A mixture of equal quantities of basic copper arsenate and sulfur dusted at the rate of 16 pounds per acre increased the yield 371 pounds, but a 1:2 mixture applied at the same rate gave an increase of only 273 pounds.

The control from calcium arsenate or cryolite was not changed by the addition of Lethane 60. Phenoxathiin (phenothioxin) mixed with equal parts of sulfur was only slightly effective when applied at 8, 16, and 32 pounds per acre.

COTTON LEAFWORM

The cotton leafworm was extremely abundant and caused serious losses in 1942. The first specimen was found in the lower Rio Grande Valley of Mexico, near Brownsville, Tex., on April 13, the earliest record of its appearance in this area. Spread was fairly slow early in the season, but by the first week in August migration of moths had caused medium to heavy infestations in east-central Texas, and by the latter part of the month the insect had spread to Louisiana, Mississippi, Oklahoma, Arkansas, Tennessee, Kentucky, Missouri, North Carolina, and Arizona. Spread in the Southeastern States was slow and, despite early incipient infestations in Florida and Mississippi, only local damage was caused in Georgia, South Carolina, North Carolina, and Virginia. Fortunately, the information on the light boll weevil infestation currently available through the insect survey permitted diversion of the insecticide stocks to the northern and western cotton areas, where leafworms were causing the most damage.

COTTON FLEA HOPPER

At Port Lavaca, Tex., mixtures of basic copper arsenate and sulfur dusted on dry plants at midday gave as good control of the cotton flea hopper as the standard calcium arsenate-sulfur mixture applied early in the morning, and better control than sulfur, calcium arsenate-sulfur, micronized sulfur, or micronized sulfur-calcium arsenate applied at midday. Although sulfur alone does not give the best control of the flea hopper, especially when other insects must be controlled, it can be satisfactorily used during the emergency if arsenicals and copper insecticides become unavailable. The studies of varietal resistance of cotton to flea hoppers have been postponed until after the war.

BEE CULTURE

HONEYBEES VALUABLE SEED-PRODUCTION AGENTS

The urgent need for increased food production has focused attention on the important part played by honeybees not only in the production of honey and beeswax but also in the pollination of important seed and fruit crops. Since nectar secretion is often the determining factor in attracting insects and there is pronounced competition among plants for insect visitors, emphasis has been placed on studies of nectar secretion and honey flows in relation to pollination. The mere presence of bloom does not justify the assumption that a plant is attractive to insects. For example, the star-thistle began to blossom late in May, but early in the blossoming period the nectar contained only 33 percent of sugar and was relatively unattractive to the bees. By the middle of July, however, it became a prime competitor for bee visitation when the sugar content of the nectar exceeded 50 percent.

Observations on alfalfa, which requires insect pollination, indicate that seed production may be improved by adjusting crop practices to bee activities. Alfalfa on dry soils yielded nectar containing as much as 55 percent of sugar, whereas nectar from plants on wet soils did not exceed 33 percent. Bees collecting nectar selected plants in the drier areas. Competition among plants for insect visitation is affected by the amount and availability of pollen as well as by the richness of nectar. This was clearly indicated at Davis, Calif., where bees collected nectar but no pollen from the second crop of alfalfa, other sources of pollen apparently being more available. From the third crop they collected pollen, and a heavy set of seed was obtained, although this was not the cutting ordinarily used for seed production and honeybees did no noticeable tripping of the blossoms. Thus, by controlling soil moisture through restricted irrigation and by using the third crop instead of the second for seed production, the chances for pollination would be increased.

In onion breeding, insects are required for pollination and 21 days are necessary to pollinate completely a single head with its multiple flowers. In controlled breeding experiments in the greenhouse, honeybees in bagged heads lived longer and withstood high temperatures better than blowflies, which are customarily used. When three or four bees were bagged with an onion head, sufficient nectar and pollen were available to maintain them as long as 30 days, except early in the season, when nectar secretion was too meager. A bee smoker was modified so that it could be stocked with bees and a selected number blown into each bag.

Maintaining the strength of colonies of honeybees used in greenhouses for pollination of seed crops is of primary importance. Colonies used in greenhouses at Beltsville, Md., for pollinating cabbage, carrot, turnip, and beet stayed in good condition for 5 months when fed pollen-soybean flour cakes, and they effected an excellent set of seeds. These cakes are subject to mold, however, and moldy cakes are useless for bee feed. When 1 percent of calcium or sodium propionate was added to the cakes, they did not mold and were consumed readily by the bees.

DISEASE RESISTANCE OF EXPERIMENTAL STOCK STUDIED

In studies of the resistance of honeybees to American foulbrood, carried on cooperatively with the Agricultural Experiment Stations of Arkansas, Iowa, Texas, Wisconsin, and Wyoming, 575 queens of experimental stock were reared, of which 270 were distributed to State agencies for testing and observation. Inoculation of individual larvae has given more accurate information on the resistance character of experimental stock than has the testing of full colonies. This test is especially useful in the selection of queens for breeding. Considerable increase in the number of colonies without disease has been shown by two lines of stock now in the fifth generation.

NOSEMA CONTRIBUTES TO QUEEN SUPERSEDURE

Nosema disease was found in 88 percent of 180 packages of bees shipped from the South. Of 56 queens that were superseded, more than 25 percent were infected with Nosema spores. This strongly suggests that Nosema contributes directly to supersedure. Both bees and feces in colonies showing typical winter dysentery were heavily infected with Nosema organisms.

SELECTION AND BREEDING OF HONEYBEES AFFECTS HONEY YIELDS

Seven generations of inbreeding by brother-sister matings decreased the viability of brood to 35 percent, reduced the size and variability of body parts, and reduced variation in distribution of pigmentation on the abdomen to such an extent that individuals were practically indistinguishable from one another. In the sixth generation drone brood were more viable than worker brood produced by the same queens. By thus reducing colony strength continued inbreeding can be a cause of poor honey crops.

Crossing of a black and a yellow strain and a study of backcrosses indicated that neither color is dominant, but that pigmentation depends on many genes, each having a slight effect. Hybrid colonies consisting of several blood lines produced no more honey than the best of the parent strains. Of 23 groups of sister queens used in testing stock, the average honey yield of the best group was 3 times that of the poorest.

Comparisons of artificial matings with natural matings at isolated stations, using an inbred yellow strain, showed that a distance of 2 miles is not sufficient isolation to insure pure matings in midsummer when drones are plentiful.

POLLEN AND HONEY STUDIES

Pollen in appreciable tonnage can be obtained by utilizing honeybees as collecting agents. Annual pollen yields were determined in various sections of the West with the aid of pollen traps attached to hives. The yield per colony ranged from 16 to 53 pounds, and the average yield per colony for seven areas was 28 pounds.

The analysis of pollen stored in the hive appears to be of value as a means of determining arsenical poisoning of bees. Where poisoning was not suspected, the arsenic trioxide content of stored pollen ranged from 0.44 to 1.25 micrograms per gram of pollen. In 24 samples in which poisoning was suspected, the amount of arsenic trioxide ranged from 3 to 38 micrograms per gram of pollen.

As a byproduct of studies dealing with the ratio of beeswax to honey, naturally crystallized honey was obtained which had as fine a grain as commercially processed (crystallized) honey. The honey was separated from the wax by centrifuging the crushed combs at 1,200 revolutions per minute.

SUBSTITUTE MATERIALS FOR SHIPPING BEES

Cages made of plywood give some promise of utility for shipping packaged bees, but they weigh more than screen cages and do not permit ready inspection. In the search for substitutes to take the place of feeder tin cans for packaged bees, cardboard, although more fragile and superior in no way, was sufficiently promising to be used in case of emergency.

INVESTIGATIONS OF INSECTS AFFECTING MAN AND ANIMALS

MOSQUITO INVESTIGATIONS AID MILITARY OPERATIONS

In the global war that we are now waging, the control of diseases prevalent in the various theaters of action is a problem second only to military strategy. Since malaria, yellow fever, dengue, filariasis, and perhaps other diseases can be carried only by mosquitoes, the research on these pests has been realined to correlate it more closely with the exigencies of war.

With funds provided by the Office of Scientific Research and Development, the Bureau has continued to supervise projects looking toward the development of repellents and a more satisfactory larvicide for mosquitoes, particularly those carrying malaria. Three fairly good repellents have been recommended for use by the military forces, and a new anopheline larvicide that promises to be more effective than any previously known has been discovered.

An entomologist acting as liaison officer visited all Army Service Command headquarters and 23 posts to give advice and demonstrations on the control of insect pests, particularly mosquitoes, that affect the armed forces.

Experiments were continued to determine, by the use of sod-sampling methods, the numbers of mosquitoes that develop in certain types of salt-marsh areas in the Southeastern States. The relative efficiency of ditches dug at different intervals in the marsh and the possible use of oil emulsions as larvicides in preventing flights of salt-marsh mosquitoes were also studied.

In strongly saline water with heavy vegetation 30 gallons of fuel oil per acre of water surface controlled the breeding of salt-marsh mosquitoes at New Smyrna Beach, Fla. Under similar conditions 100 gallons of a newly developed fresh-water oil emulsion gave 86 percent control and 150 gallons gave 97 percent control in 4 hours. The tests made on a small scale suggest that fresh-water emulsions are promising for rapid treatment of salt-marsh areas. A further study of oil emulsions in fresh-water areas of the Pacific Northwest suggests that, in addition to the new emulsifiers reported last year, three others show considerable promise. Such control methods use small amounts of oil that can be mixed with the water from the mosquito-breeding places at the time of application. They offer economy of both materials and labor.

The results of these investigations are being made available to those concerned with mosquito control in and around military camps.

TICKS AFFECTING MAN AND ANIMALS

The need of controlling ticks that transmit Rocky Mountain spotted fever to man or seriously affect the health of animals is paramount. An aqueous spray containing 1.5 percent of sodium fluoride and 0.5 percent of nicotine sulfate with a wetting agent was found to be fairly effective against disease-carrying ticks on camp sites, when applied once a week at the rate of 170 gallons per acre. Studies of the Gulf coast tick have been made to find a substitute for rotenone and other critically needed materials. Concentrations of the spinose ear tick, also affecting animals, were found under salt troughs on the range and in corrals. Preliminary tests suggest the practicability of treating these concentrations by chemicals.

PROTECTION OF FOOD AND CLOTHING FROM INSECTS

During the year special services and treatments for demonstration purposes were given to 43 Government agencies for various insect pests of food and clothing. In addition, tests were made on mothproof woolens and on protective features of various types of packages used in marketing food supplies. A new insecticide, 2,2-bis(parachlorophenyl)1,1,1-trichloroethane, to be known as DDT, offers considerable promise as a mothproofing agent when used in a 1-percent concentration.

In 5 locations 746,591 bales of wool in 12 warehouses were inspected for insect damage. The compressed bales can apparently be stored for years without a great deal of damage. It was not necessary to fumigate stores of this type of bale. Insecticidal aerosols killed adult moths that developed in wool houses, but did not affect the immature stages.

MEAT AND LEATHER PRODUCTION INCREASED THROUGH CONTROL OF LIVESTOCK PESTS

Protection of livestock against the destructive attacks of the screwworm is imperative under present conditions. Since diphenylamine and Turkey-red oil, two ingredients in Smear 62 for treatment of screwworm infestations, are critical materials, substitutes are being sought. One new wound protector, which does not contain a larvicide, has shown considerable promise in preventing infestations of shear cuts in sheep and goats as well as in dehorning and castration wounds. The new formula has also shown protection against the fleece worm (*Phormia regina* Meig.).

The injuries to cattle caused by the horn fly, which gives rise to screwworm infestations, have been reduced by the use of sprays or traps for the control of horn flies. An insecticidal aerosol was found to be very effective when applied to the hair on the necks and backs of cattle as they passed through a chute. Single treatments with DDT in a spray killed horn flies for 3 to 4 days after treatment and kept the population of flies to a low point for about 2 weeks.

The holes found in many hides otherwise of high quality are caused by cattle grubs, the young of the heel fly. There is no known substitute for rotenone in the treatment of large numbers of animals in-

fested with these pests, and it has been necessary to devise means of extending the use of such supplies as may become available for this purpose. Extracts of derris or ground derris root diluted with pyrophyllite or tripoli earth to a rotenone concentration of 1.25 percent have been recommended.

Animals devitalized by infestations of lice seriously handicap the effort to produce the maximum quantities of meat. Because of the shortage of rotenone for treatment of cattle to combat the short-nosed louse, efforts were continued to perfect a substitute dip or spray for this pest. Of 25 chemicals tested, nicotine sulfate and Lethane 60 were fairly satisfactory when used alone, and they were very efficacious when used together.

Another spray, containing 0.5 percent of DDT, gave a complete kill of all active stages of the short-nosed louse. It persisted on the hair of the animals long enough to kill the young lice that hatched from the eggs. It was also effective against blue, red, and yellow lice of goats when applied in a single dipping for goats with hair of medium length.

CONTROL OF DOG FLIES AIDS MILITARY MANEUVERS

Technical advice was furnished to Federal agencies responsible for the control of dog flies (also called stableflies) that affect the military personnel along the northwest coast of Florida. Studies of treated and untreated grass made possible by these large-scale control operations demonstrated that the grass deposited on the beaches by the tides stimulated intensive egg laying only when fermented.

One of the mosquito repellents recommended to the armed forces was found to be very effective in protecting dogs and horses from dog flies. This is of special interest to the Coast Guard patrols, because not only are the animals protected from bites of the flies and mosquitoes, but there is also less opportunity for dogs to become infested with heart worms (*Dirofilaria immitis* Railliet and Henry) through mosquito bites.

INSECT IDENTIFICATION

Identifications made and reported to senders of 19,133 lots totaled 42,600. Of these 35.6 percent were for insect interceptions in imports from abroad; 31.0 percent for control and research activities of this Bureau and other Federal agencies; 13.8 percent for agricultural colleges, experiment stations, and other offices of the States and insular possessions; 15.0 percent for individuals, private agencies, and pest-control operators in the United States; and 4.6 percent for foreign institutions and governmental agencies, largely in the Western Hemisphere.

Service activities directly associated with the war included identification of insect material comprising 135 shipments from military sources; personal instruction or assistance to 74 officers of the Army, Navy, and Public Health Service in identification and classification of mosquitoes and other insects affecting human health; accumulation and organization in readily usable form of available pertinent information on distribution, habits, and medical significance of insects known from (1) the countries bordering the Mediterranean and

(2) Australia, New Zealand, and the South Pacific Islands, for the Office of the Surgeon General, War Department; preparation of insects for instructional use at the Army Medical School and the Navy Medical Center; and a major part in the preparation of the War Department publication, The Anopheline Mosquitoes of the World, A Guide to Their Identification, Distribution, Habits, and Relation to Malaria.

Research to provide bases for correct and more complete identifications in various economic insect groups resulted in completion of 39 manuscripts, totaling 2,465 pages, on insect classification.

FOREIGN PARASITE INTRODUCTION

IMPORTATIONS FROM SOUTH AMERICA

The study and importation of natural enemies of crop pests were limited during the year to parasites from South America, especially Brazil, Argentina, and Peru. Forty-one consignments, totaling 51,888 insects of 7 species, for use against 5 insect pests, were forwarded to the United States, and 13 consignments, comprising 10,180 of 4 species, for use against 2 pests, were forwarded to Puerto Rico.

Importations of parasites of cotton insects consisted of 42,360 adults of *Triaspis vestiticida* Vier. and 919 adults of *Microbracon vestiticida* Vier. They were forwarded from Peru for direct field release against the boll weevil in Texas, Louisiana, and Florida. Additional rearing stocks of *Microbracon vulgaris* (Ashm.), a parasite of the pink bollworm in Brazil, were also imported.

A large number of sugarcane borer parasites were forwarded from Brazil to Puerto Rico. One small consignment of *Lixophaga diatraeae* Towns., a parasite of the sugarcane borer, was obtained from Cuba, and 4 consignments of a predaceous beetle, *Pyrophorus luminosus* (Ill.), consisting of 946 adults and larvae, were received from the Puerto Rico Agricultural Experimental Station and released in infestations of cane grubs in southern Florida.

Parasites of truck-crop insects imported during the year comprised 5,448 puparia of *Lydinolydella metallica* Towns., a Brazilian parasite that is being colonized on the Mexican bean beetle, and 1,107 puparia of *Epiplagiops littoralis* Blanch. and 664 cocoons and larvae of *Porizon* sp., parasites of the vegetable weevil recently found in Argentina.

COOPERATION WITH STATE, TERRITORIAL, AND FOREIGN ORGANIZATIONS

In the cooperative work with the Puerto Rico Agricultural Experiment Station, 4 consignments of sugarcane borer parasites, consisting of 6,827 puparia of *Paratheresia diatraeae* (Brèthes) and 40 cocoons of *Ipobracon amabilis* (Brèthes) were forwarded from Brazil, while 3,313 puparia of the cotton stainer parasites *Acanolona peruviana* Towns. and *Hyalomya chilensis* Macq. were shipped from Peru. Stocks of the vegetable weevil parasites *Epiplagiops littoralis* Blanch. and *Porizon* sp., obtained from Argentina, were sent to the California Agricultural Experiment Station for rearing and colonization.

Through the courtesy of the British Imperial Parasite Service, two small consignments of *Ichneumon caudatus* (Ratz.) and *Cryptus sexannulatus* Grav., which attack codling moth larvae, were received.

At the request of the Office of Economic Warfare, arrangements

were made for the importation of *Plaesius javanus* Erichson from Fiji, and a consignment of 493 adults was forwarded to Honduras for release against stem-feeding grubs.

Cooperative work with the Mexico Department of Agriculture was started on the biological control of the citrus blackfly on the west coast of that country. An effective parasite, *Eretmocerus serius* Silv., originally imported from Malaya, is being sent from the Canal Zone. Costs are borne in part by the Office of the Coordinator of Inter-American Affairs. One consignment of *Aphelinus mali* (Hald.), an effective parasite of the woolly apple aphid, was forwarded to Mexico.

BIOLOGICAL CONTROL OF BLACK SCALE HINDERED BY OIL SPRAYS

Oil sprays applied against the black scale on citrus in California caused a very high mortality of immature stages of the effective parasite *Metaphycus helvolus* (Compere), whereas when this scale was controlled by hydrocyanic acid fumigation the parasite mortality was low. In order that this parasite may be given the maximum opportunity to control the scale, the treatment applied should be that which interferes least with the increase of the parasites. Continued spraying with oil would probably entirely prevent control by biological agencies.

CONTROL INVESTIGATIONS

TOXICITY TESTS BRING IMPROVEMENT IN AEROSOLS

In connection with the extensive use by the armed forces of insecticidal aerosols to control disease-carrying flies and mosquitoes, precise methods for determining their toxicity have been developed, and many commercial samples have been tested. Two factors that affect the toxicity of aerosols were discovered which are of outstanding importance in their manufacture. First, an increase in the concentration of nonvolatile materials, up to 16 percent at least, increases the toxicity, and second, a capillary tube with a 0.017-inch bore disperses the aerosols more effectively than the oil-burner nozzle previously used. In line with the need for conserving the pyrethrum supply, an aerosol solution containing 0.6 percent of pyrethrins and 8 percent of sesame oil in dichlorodifluoromethane was found to be as toxic to flies as the original aerosol solution, which contained 1 percent of pyrethrins and 2 percent of sesame oil.

SUBSTITUTES FOR CRITICAL MATERIALS TESTED

In the search for new materials that could be substituted for critical insecticidal products, emphasis was placed on those that were commercially available. Among the commercial products that were tested, 2,2-bis(parachlorophenyl)1,1,1-trichloroethane was of outstanding merit. It was found to be tolerated by plants and to control 7 species of leaf-eating larvae, as well as houseflies and cockroaches. Of 138 new compounds, 40 showed toxicity to one or more species of plant-feeding insects. The most promising were 4-methylcyclohexanone semicarbazone, 2,4-dimethyl-3-pentanone semicarbazone, parabromobenzenesulfonamide, and parabromo-*N*-isobutylbenzenesulfonamide. Of 184 synthetic organic materials and 110 plant extracts tested against houseflies, 2,2-bis(parachlorophenyl)1,1,1-tri-

chloroethane and its bromine analog were outstanding among the synthetics, and extracts of *Willardia mexicana* S. Wats., *Ryania speciosa* Vahl, and *Amorpha fruticosa* L. were promising plant materials.

Among 88 samples tested as synergists for pyrethrum, 3 piperonylamides and piperine were found to be useful against houseflies and 5 materials were found that increased the effectiveness of pyrethrum dusts against leaf-feeding larvae.

In cooperation with the Bureau of Agricultural and Industrial Chemistry, 38 new nicotine compounds were tested against plant-feeding insects. Cuprous mononicotine thiocyanate, cuprous dinicotine thiocyanate, and cuprous nicotine cyanide were found to be highly toxic to insects and relatively noninjurious to plants.

NEW FUMIGATION PROCEDURES DEVELOPED

The experimental work on the fumigation of table-stock sweetpotatoes for the sweetpotato weevil was completed and shown to be practical. The occasional break-down of sweetpotatoes in the fumigation of cured stocks appears to be associated with the postfumigation storage temperature. Sweetpotatoes held at 70° F. or above for 24 hours following fumigation showed little or no break-down. Data on the fumigation of sweetpotato draws and vine cuttings were published.

New fumigation schedules for the white-fringed beetle were developed, and their use for the treatment of nursery stock was authorized. A method of treating nursery plants in the nursery row for Japanese beetle larvae with a solution of methyl bromide was devised, and its use authorized under the Japanese beetle quarantine. New fumigation schedules for carload lots of produce for certification under this quarantine were developed and authorized.

BODY LICE CONTROLLED BY FUMIGATION OF CLOTHING

Investigations on the fumigation of body lice in clothing and equipment, conducted for the United States Army in cooperation with the Division of Insects Affecting Man and Animals, have resulted in the adoption of two general methods, vault fumigation and individual-bag fumigation. For delousing large quantities of clothing in a short time, permanent or demountable vaults, each holding approximately 75 barracks bags filled with clothing, are operated in batteries. In the second method one soldier's outfit is put in a gastight bag together with the fumigant sealed in a glass ampule, and after the bag is closed the ampule is broken. In emergencies the infested clothing can be fumigated in pits in the ground covered with a raincoat, newspapers, or similar available materials. Both methods require only a short exposure period. Dosage schedules down to 0° F. have been developed, and information has been obtained on the exposure to low temperatures alone at −10° and below that is required to kill all stages of the louse. Approximately half a million louse eggs have been used in these tests.

In addition to the development of methods and dosage schedules, test models of the equipment have been built and demonstrated to Army personnel, and technical advice has been given in adapting the methods to large-scale use.

INSECTICIDE INVESTIGATIONS

Chemical work connected with the development of new insecticides and fungicides resulted in the publication of 81 scientific articles and the granting of 10 United States patents covering new insecticides. Much of the experimental work was directed toward the discovery and improvement of insecticides for use by the armed forces, since control of disease-carrying insects is of prime importance during wartime. Attention has also been given to finding substitutes for standard insecticides of which supplies are now scarce.

AEROSOL "BOMBS" IMPROVED

The method of combating insects by means of aerosols dispensed from small cylinders, called bombs, has proved so successful that the demand for the bombs has increased phenomenally. The entire output is now used by the Army and Navy. This demand has entailed a great deal of development work on solutions and containers. The aerosol has been made by dissolving pyrethrum extract and sesame oil in liquefied dichlorodifluoromethane, a refrigerant known commercially as Freon, but diminishing supplies of pyrethrum and Freon have necessitated a search for substitutes. It has been found that for some uses Freon can be replaced in part by methyl chloride, propane, or butane.

NEW SYNTHETIC WITH VARIED USES

The Division of Insecticide Investigations took an active part in the program for the development of mosquito larvicides, louse-control agents, and insect repellents by furnishing hundreds of synthetic organic compounds for testing. One mixture, containing pyrethrum, 2,4-dinitroanisole, a stabilizer, and isobutylundecylenamide, proved acceptable to the Army for the control of body lice.

The properties of the DDT synthetic have been determined and means of emulsifying it developed, so that suitable preparations can be made for application against houseflies, codling moth larvae, and Japanese beetles, tests against which have given promising results. Investigations of the toxicity of this new insecticide to higher animals and man have shown it to be definitely poisonous when ingested or absorbed, but there appears to be a margin of safety between amounts effective for insect control and those dangerous to man and animals. Investigations to determine more definitely the range of toxicity of the material and how it may be safely used are necessary before it can be recommended for general use.

DOMESTIC SOURCES OF ROTENONE EXPLORED

The supply of rotenone-bearing roots from the East Indies was completely stopped by the war, and the quantity obtainable from South America proved insufficient for the needs of the Nation's food producers. Attention was therefore focused upon possible domestic sources, and two plants received particular attention. On the basis of certain qualitative tests, *Amorpha fruticosa* from Oklahoma and *Pachyrhizus erosus*, or jicama (yam bean), from Mexico were judged to contain rotenone, but investigation failed to confirm its presence.

ANALYTICAL AND SERVICE WORK

About 750 samples of miscellaneous insecticides were analyzed in connection with the experimental work of other divisions of the Bureau. Special attention was given to samples of barbasco from the Office of Economic Warfare and of pyrethrum from the War Production Board. A study was made of smelter waste containing calcium arsenite, of which about 20,000 tons are available, to determine whether it might be adaptable to insecticidal use or to the uses of the Chemical Warfare Service. New analytical procedures were developed for paradichlorobenzene in soil, for ethylene dichloride in emulsions, for residues of xanthone on sprayed apples, for 2,4-dinitroanisole and 2,4-dinitrochlorobenzene in louse powder, for nornicotine in the presence of nicotine, and for phenothiazine spray residues.

MEXICAN FRUITFLY CONTROL

Each fall and winter there appears to be a northward flight of Mexican fruitflies which annually causes infestations of citrus plantings in Texas. The spread of the insect has been halted, however, and further spread prevented through the sterilization of fruit, certification of shipments, and regulation of movement from the regulated area as provided under the quarantine.

As is common with other insects, there are years of both high and low infestation. During the harvesting season of 1942–43 there was a rather light infestation. Although flies were present over the area, they were not numerous enough to cause heavy general infestations until late in the spring of 1943. In previous seasons as many as 2,000 or more citrus plantings have been found infested, and more than 13,000 flies have been trapped. During the past season, however, only 291 plantings were found infested and 224 flies trapped.

To prevent the spread of the Mexican fruitfly within the United States, it is highly important that fruit from zones where infestation has been found be sterilized before shipment. The sterilization method used in Texas was developed by employees of the Department. The fruit is treated in especially adapted rooms with moisture-laden air heated to 110° F., and held at that temperature for 6 hours after the inside of the fruit has reached that point. The entire process requires 14 hours and costs approximately 50 cents a ton. During the season of 1942–43, 1,560 equivalent carlots were sterilized.

The Texas citrus industry is relatively young. Since 1927, the year the Mexican fruitfly was first found in Texas, the production of citrus fruit has increased from approximately 1,000 carlots to more than 54,000 carlots during the season of 1942–43. Owing to the scarcity of labor, the harvesting season was lengthened 1 month, the host-free period being correspondingly shortened.

JAPANESE BEETLE QUARANTINE AND CONTROL

TRAP SCOUTING IN NONREGULATED TERRITORY

Because of increased costs of labor and supplies, the 1942 trapping program was limited to the placement of 55,354 traps in 242 cities and towns in 17 States, as contrasted with the use of 78,509 traps in 462 localities in 39 States in 1941. With this restricted program

trapping sites were selected where there was the most likelihood of beetle spread. All localities outside the regulated area in which incipient or established infestations were known to exist were included.

Distribution of small lots of traps to the Bureau's field stations throughout the country was abandoned for the season. In control areas such as St. Louis, Detroit, and Indianapolis trapping was temporarily discontinued in sections previously treated with lead arsenate. Trapping was also curtailed in other areas that had shown negative results for several successive years. Thus, while the number of traps operated was considerably less than last year, the effectiveness of the program was not reduced proportionately.

Beetles were captured in 122 of the communities where traps were operated, 33 representing first-record finds. Of the 122 infestations, 71 were of a few scattered beetles each, but the remaining 51 were of such proportions as to indicate establishment of the insect in these localities.

All trapping in seven localities in Maine and three cities in Wisconsin was with negative results. In Florida, Georgia, Kentucky, Tennessee, and Vermont the few infestations determined were relatively unimportant.

The situation in Illinois showed a pronounced improvement, as disclosed by the season's trapping. Solitary beetles were trapped in Bloomington, East St. Louis, and Highwood. At Highland Park, where soil treatments had been applied since the trapping of 5,608 beetles there in 1941, only 173 beetles were taken. Trap captures in Chicago numbered 170, as compared with 407 in 1941.

In Indiana negligible infestations were found to have persisted in six localities. In Richmond 556 beetles were trapped in sections where only four were caught the preceding season.

In Maryland the trapping was again carried on by the State, with 31,924 traps operated. Beetles captured in cities and towns totaled 43,740,561, or 4.374 tons. Most of these were caught within the present regulated area. Beetles were trapped in varying numbers in 17 cities and towns outside the infested zone.

In Michigan an infestation of 80 beetles was discovered at Flint. Trapping in Detroit showed a reduction from the infestations of previous years, with only 32 beetles caught. Minor infestations were checked at Birmingham, Dearborn, Lincoln Park, Melvindale, and River Rouge.

Trap collections in Missouri were the smallest in years, being limited to a solitary beetle at the St. Louis-Lambert Airport and six beetles in St. Louis.

An infestation was found in a borough adjoining the Erie, Pa., isolated area.

In South Carolina established infestations were discovered in Florence and Greenville, along with finds of solitary beetles in four other localities.

In North Carolina 22 infestations were found, and in New York and Ohio 21 each.

Positive results were obtained in 15 Virginia cities and towns, although 9 of the infestations were negligible.

Four established infestations and four of lesser importance were determined in nonregulated territory in West Virginia.

SUPPRESSIVE MEASURES

Surface-soil treatments with lead arsenate of isolated infestations were applied to 945 acres in the fall of 1942 and 117 acres in the spring of 1943, a total of 1,062 acres. Treatments were applied in 53 localities, 42 in the fall and 11 in the spring. This is the most extensive cooperative State-Federal soil-treating program thus far undertaken to suppress isolated infestations of the Japanese beetle. All treatments were at the rate of 500 pounds per acre. In cooperation with the Division of Fruit Insect Investigations, spores of the milky disease of the Japanese beetle grub were distributed in sections of the infested area in Hendersonville, N. C.

Most extensive of any State treating program thus far was that in Ohio, where 424 acres were treated at 18 isolated infestations. The largest treated areas in the State were 123 acres at Bellevue, 76 acres at Marietta, 47 acres at Gallipolis, and approximately 28 acres each at Crestline and Marion.

Treatments in Illinois comprised 46.4 acres in Chicago and 20 acres in Highland Park.

In Indiana 5.7 acres in Logansport and 18.9 acres in Richmond were treated.

Michigan's control program included applications to 99.2 acres in Birmingham, Dearborn, Detroit, Flint, Lincoln Park, Melvindale, and River Rouge.

Very little work was required in St. Louis, Mo., this year, 7.3 acres being the extent of the treatment.

In New York State the treated territory involved 8 acres at Avon, 10.9 at Jamestown, 31 at Newark, 29.5 at Niagara Falls, 16.4 at Silver Creek, and 5 at Waterloo.

North Carolina's extensive treatments totaled 292.5 acres in Charlotte, Durham, Elizabeth City, Gastonia, Greensboro, Hendersonville, High Point, Raleigh, Rocky Mount, Weldon, and Wilson.

For the first time since 1936 soil treatments were necessary in South Carolina. At Florence 4.7 acres and at Greenville 7 acres were treated.

In Virginia 35 acres were treated in Dayton, Harrisonburg, Luray, and Woodstock.

The cooperation afforded by the Bureau was the same as in previous years, comprising the furnishing of spray-truck equipment, driver operators, and men to assist State officials directing the work. All other labor, material, and supplies were furnished by the States or municipalities.

MODIFICATION OF QUARANTINE REGULATIONS

In a modification of the Japanese beetle quarantine regulations effective January 14, 1943, the regulated zone was extended to include additional territory in Maryland, New York, Pennsylvania, Virginia, and West Virginia. Territory on the Eastern Shore of Maryland and on the mainland bordering Chesapeake Bay constituted the only sizable extension. At the same time the area from which the movement of fruits and vegetables by motortruck or refrigerator car is regulated was extended to include a magisterial district each in Norfolk and Princess Anne Counties, Va., the remaining sections of the Eastern Shore of Maryland previously excluded, nine townships in Cumber-

land and York Counties, Pa., and a few townships each in Bergen, Morris, Passaic, and Warren Counties, N. J.

HIGHWAY-INSPECTION SERVICE

Inspection of vehicular traffic was very much reduced over previous years, being limited to the examination of south-bound trucks leaving the regulated area. Before and after the season of adult flight most of the work was performed by mobile patrols, which shifted their stations daily to cover wide territory. During the height of the 1942 beetle season 29 inspectors were assigned to 7 permanent stations and 2 mobile patrols. Previous experience had demonstrated that the roads chosen for patrolling were those carrying most of the out-bound traffic in farm produce. Of 88,643 trucks examined, 749 were found to be transporting uncertified fruits and vegetables. Most of this material was either inspected at the station or returned to the inspection platform for examination. A few restricted articles were surrendered to the inspector. Only three attempts were made to violate the quarantine.

In addition to the interceptions of uncertified material, 899 trucks that were returning to southern points, either empty or with empty crates, coops, or baskets, were found to have become infested as they drove through the area of heavy flight; 4,779 live beetles were removed from these trucks. Farm products and plant material examined by the road inspectors yielded 8 adults and 59 grubs.

CERTIFICATION AND TREATMENT OF NURSERY STOCK

Nurseries classified under the quarantine regulations numbered 1,172 at the end of the fiscal year. This reduction of 140 from the previous year is attributable to the closing of many small nurseries and greenhouses on account of labor or material shortages. The larger establishments, involving the heaviest inspection load, continued operations. Many nurseries relinquished their classification because they receive just as good service without it and are not obliged to comply with certain reporting requirements. Of the remaining classified nurseries and greenhouses, 260 were infested, and their stock was eligible for certification only after being freed from soil and fumigated or otherwise treated. The remainder, 912, were uninfested and had a preferred status.

Administrative instructions issued September 5, 1942, authorized the use of ethylene dichloride dip for the treatment of plants with root masses or balls up to 10 inches minimum diameter. Such plants may be dipped in the fumigant while unpacked, wrapped, or in unglazed clay pots. In March the size of the ball that might be so treated was increased to 16 inches. Later authorization was granted for the surface application of the emulsion to plants in pots or tubs.

A new method was developed for treating growing nursery stock in the field for compliance with the certification requirements. The treatment involves preparation of a dilute solution of methyl bromide and its application to the soil surface about individual items of stock within collar-enclosed areas. Directions for preparation and application of these solutions were issued September 16, 1942.

Plant growers, particularly those specializing in azaleas, were quick to adopt both these treatments in preference to methyl bromide fumigation. They are comparatively simple, and the cost of equipment and materials is low. The expensive item of extra handling may be eliminated by treating the plants as they are moved from the outside to winter quarters. A report distributed in October listed 26 varieties of azaleas, 59 species of hothouse plants, 28 types of trees and shrubs, and 49 varieties of perennials that had been treated experimentally with ethylene dichloride without visible injury.

Two new treating schedules, providing for lower temperatures for methyl bromide fumigation of potted or bare-rooted plants, were authorized in administrative instructions issued September 18, 1942.

CERTIFICATION OF FRUITS, VEGETABLES, AND CUT FLOWERS

Centers for the inspection and certification of fruits and vegetables were established at 25 points throughout the heavily infested area during the period of adult flight, from mid-June to September 8. In the course of this inspection 893 beetles were removed from 1,658,213 packages of commodities certified for transportation. Among the certification activities were fumigation of 2,909 loaded refrigerator cars with methyl bromide, fumigation of 407 empty cars with hydrocyanic acid gas, and inspection and certification of 593 additional cars before loading.

ARTICLES CERTIFIED AND VIOLATIONS INVESTIGATED

Nursery and ornamental stock totaling 39,547,109 plants and 125,435 pounds of soil and manure were certified for shipment from class III establishments. In addition, 19,194,066 plants were shipped under certification from class I establishments to points in nonregulated territory, and to other classified establishments in the regulated zone. Furthermore, 28,402,529 plants and 4,852,025 pounds of soil and manure were certified for shipment between dealers within the regulated area.

A total of 187,166 certificates of all types were used to cover quarantined products moving to nonregulated territory.

Investigations were made of 502 apparent violations of the quarantine regulations, and 1 conviction was obtained.

CONTROL OF PHONY PEACH AND PEACH MOSAIC DISEASE BRINGS MARKED SUCCESS

Through joint activities of Federal and State agencies and growers, several areas formerly infected with the phony peach or peach mosaic have been rid of these virus diseases of serious importance to the peach crop. In the summer of 1942 inspections were conducted in 221 counties in 15 States from South Carolina to California. Following a 3-year disease-free period, standard State phony peach quarantines were lifted from Kentucky and North Carolina and from several counties in Arkansas, Mississippi, Tennessee, Texas, and South Carolina. Peach mosaic regulated areas were modified to release 2 counties each in California and Colorado, 4 in Texas, and 1 in Utah, and to add 4 counties in Texas that had been found infected.

In the spring of 1943 the environs of all known peach-growing nurseries and budwood sources throughout the infected areas were inspected, and only 3 nurseries and 1 budwood source failed to qualify for disease-free certification. This practice of annual inspection and requiring the destruction by a specified date of any infected trees within a mile of the production source affords protection to millions of peach nursery and orchard trees and enables growers to obtain disease-free stock.

Within the commercial areas more heavily infected with peach mosaic disease substantial reductions in infection have permitted the continued economic production of peaches. Particularly good progress has been made since 1936 in eradicating the phony peach disease. In 10 of the lightly infected States the incidence of the phony trees was reduced from 10,923 in 1936 to 419 in 1942.

ORIENTAL FRUIT MOTH FOUND OVER LARGE NEW AREA IN WEST

Following the discovery of the oriental fruit moth in southern California in the fall of 1942, a cooperative Federal-State survey for infestations in the western half of the United States was begun in 1943. The moth was previously known to exist in the East and in the South as far west as Kansas, Oklahoma, and Texas, and quarantines restricting the movement of hosts of the pest had been established by nine Pacific and Rocky Mountain States.

This survey has already disclosed a newly infested area extending from northeastern Texas through Oklahoma, eastern and east-central Kansas, and southeastern Nebraska into southern Iowa, including 61 counties. This was the first record of the occurrence of the moth in Nebraska or Iowa. Reports from the California Department of Agriculture indicate that infestations have been found in 5 southern counties in that State.

TRACE OF CITRUS CANKER LOCATED

Federal-State inspection for citrus canker in 1943 was conducted on more than 5,000 properties in 14 Texas counties. An intensive search was made for any vestige of the disease in areas where it is known to have existed since its discovery in the State more than 30 years ago. Search was also made on formerly infected properties to find and destroy any seedlings of citrus, particularly of the trifoliate-orange, that may have germinated since the parent trees were destroyed. On 1 property at Navasota, on which citrus canker was discovered in February 1941, a lesion was found on only 1 of 48 trifoliate-orange seedlings 2 inches high that were examined in January 1943. No other citrus canker has been found in this country since 1941.

GYPSY AND BROWN-TAIL MOTHS CONTROL

Early in the year it was noted that the retirement of A. F. Burgess, in charge of the Division of Gypsy and Brown-Tail Moths Control, would occur on November 1, 1943. In realization of the wealth of experience gained by Mr. Burgess during 36 years of continuous service in both research and control directed against the gypsy moth,

it was decided, after consultation with him, to relieve him of all administrative responsibilities so that he might devote his entire remaining time to the preparation of a consolidated record covering his period of service. R. A. Sheals, previously assistant chief of the Division of Domestic Plant Quarantines, was appointed leader of this Division.

Since 1924, when records of defoliation by the gypsy moth were first kept, an annual average of somewhat more than 200,000 acres of woodland, chiefly in New England and New York State, has had from 50 to 100 percent of its leaf surface destroyed by the pest. During the current year defoliation was the lowest recorded since 1924, only 40,000 acres showing the effects of heavy feeding.

For the duration of the war the objective of gypsy moth control is to protect the accomplishments of previous work and to prevent spread of the pest by applying control measures to reduce intensity of infestations in the Scranton-Wilkes-Barre area of Pennsylvania, in western New England, and east of the Hudson River in New York; to eradicate the few existing isolated infestations in Pennsylvania and west of the Hudson River in New York; and to conduct annual surveys to determine the spread of the pest and its intensity, so that information may be available upon which to base sound programs of work.

NEW SURVEY METHODS PROVE PRACTICAL

During July and August, in cooperation with the affected States, a survey, using cages containing a sex attractant obtained from female pupae, was made over a wide strip of wooded area from the western known limits of the infestation in New York State southwestward to the northeastern limits of the infestation in Pennsylvania. Light and scattered infestations were found in Albany, Schenectady, Saratoga, Greene, and Ulster Counties in New York, but none in Pennsylvania. This type of survey, called assembling-cage work, has been used in previous years but never before on such an extensive scale. Because of its economy of operation and effectiveness, this method will be used more generally in the future.

During the winter months it has been customary to conduct surveys by scouts operating in strip formation, especially in the periphery of known infestations, to determine the location and intensity of the infestation. This method is effective, but manpower requirements are high. The method of survey was modified during the year. Experienced men operating singly or in pairs were used to conduct a more rapid type of survey. Information as to the status of infestation was obtained in the areas in New York State west of the Hudson River where male moths had been attracted by the sex attractant, throughout the infested area in Pennsylvania, and in the barrier zone in New York and New England. The revised scouting procedure, based on the use of experienced personnel thoroughly familiar with areas of favorable growth and previous history as to infestation, is believed to be sufficiently accurate and complete to form the basis for planning control operations.

INSECTICIDES DISTRIBUTED FROM AIRCRAFT

During the year 879 acres of wooded area were sprayed with lead arsenate or cryolite by ground spray machines, and 2,047 acres were treated from aircraft. The most heavily infested portions, which were treated from aircraft, had to be gone over three times. An autogiro has been used in recent years, but in 1943 a biplane was operated in addition to the autogiro. In areas where cattle were present, cryolite was substituted for the more toxic lead arsenate used extensively in previous years, with consequent savings in erection of fences. The results indicate need for modification of the distributing apparatus used in the biplane to obtain better adherence of insecticide to the leaf surface. However, the season's work clearly demonstrated, from the standpoint of economy, the desirability and practicability of increasing the use of aircraft, especially in forest areas in rough or mountainous terrain where application of insecticides from ground sprayers is costly.

COOPERATION WITH OTHER AGENCIES

Information obtained by the Division of Forest Insect Investigations led to several of the modifications in survey and control procedure referred to previously as increasing the effectiveness or decreasing the cost of the work. State agencies cooperated wholeheartedly. Of special significance was the change in procedure in New York State, where in previous seasons the work had been conducted and financed almost entirely by the Department of Conservation of that State. In 1943 Federal and State resources available for gypsy moth control were pooled, and all work was conducted cooperatively in a more effective and economical manner than was possible without such an arrangement.

GYPSY MOTH POPULATIONS REDUCED BY ABNORMALLY COLD WEATHER

In all parts of the infested territory except near the New England coast and the river-level area in Pennsylvania, subzero temperatures killed practically all eggs deposited above the snow line. This decrease made possible curtailment of control that otherwise would have been necessary. Since the cold weather also killed many insect parasites, a rather rapid increase in moth population may be expected during the next few years.

BROWN-TAIL MOTH CONTROLLED BY STATES

All work on brown-tail moth control during the year was conducted by the affected States. Their reports indicate heavy mortality by subzero temperatures. Very little defoliation was noted.

CERTIFICATION OF PRODUCTS UNDER THE GYPSY AND BROWN-TAIL MOTHS QUARANTINE

Under the war program shipments of certified lumber exceeded last year's record-breaking total. More than 245 million board feet of lumber were certified for movement from the gypsy moth regulated area. The number of infestations removed from products inspected was smaller than in the last few years. In the course of inspection of

99,967 shipments, 1,648 egg clusters, 14 larvae, and 10 pupae of the gypsy moth were removed.

Readjustment of inspection districts and replacements, when they could be secured, were made to fill the vacancies created by the retirement of two district inspectors and the induction of a third into the Army. Temporary inspectors were employed during the heavy nursery shipping seasons. At Fryeburg, Maine, five women were among those employed as part-time inspectors.

Methyl bromide fumigation as a means of obtaining gypsy moth certification of some classes of restricted articles was introduced for the first time in October. Authorization of this method of certification was speeded because of an urgent request from the Army for the certification of a large quantity of logs to be used as shoring for heavy war equipment going overseas. Under the regular procedure it would have been impracticable to inspect this material. Therefore, experimental work already under way on the methyl bromide fumigation of forest products was rapidly concluded, and a schedule for the fumigation of both cordwood and Christmas trees was approved. Fumigation of cordwood for the Army was begun in November, and by the end of the fiscal year 28 cars had been fumigated. Beginning in February, 17 cars of fuel wood were fumigated, principally for movement to New Jersey and Pennsylvania. During May and June, 7 shipments of ship fenders were similarly treated.

Two fumigation units were provided for treating Christmas trees, and during November and December, 34 carloads, involving about 70,000 trees, were fumigated in Maine, New Hampshire, Vermont, and Massachusetts. Operators who had a choice of the tree-by-tree inspection or fumigation chose the latter to avoid the extra tying and handling of the trees. The fact that under war conditions the shippers were restricted to the use of box cars for the movement of Christmas trees facilitated the fumigation work. Although the number of Christmas trees was approximately 76 percent below that in 1941, it would have been impossible, with the limited inspection force available, to certify all these trees on the basis of visual inspection.

With continued peak demands for the inspection of lumber for war use, shipments of certified lumber from the New England States reached a new high record in August, with a total of 26,722,838 board feet certified. This topped the 24,220,489 feet certified in June 1942, which up to that time was the largest quantity certified in any 1 month since the gypsy moth quarantine was inaugurated. Because of the great demands for lumber to be used in war-production plants, the stock of dry seasoned lumber in New England was greatly depleted. The enormous quantity of lumber realized from the logs placed in storage ponds following the 1938 hurricane is practically exhausted. Most of the logs have been milled and the lumber stacked for drying. Certified lumber produced from this material is being used largely in the manufacture of shipping containers.

The demand for shavings from New England to be used in the manufacture of plastics increased the amount of this product certified. Several classes of certified stone and quarry products also showed an increase over the previous year. Much of this went into the construction of airfields, breakwaters, and war industries.

A limited amount of highway-traffic checking was performed during July in the northern districts to detect any illegal movement of re-

stricted materials. Out of 63 trucks intercepted, 9 were found to be uncertified and were compelled to return to the infested area for proper inspection and certification. A similar traffic check was made in Connecticut in August.

Transportation difficulties, scarcity of nursery help, and fewer new homes to landscape were responsible for a decrease in the amount of nursery stock shipped under certification. Some shrubbery and trees were inspected for use in camouflage work around military installations.

Further exemptions from the certification requirements were provided in administrative instructions issued November 20, 1942. One, making sawdust available to war industries, applied to sawdust from finished lumber, subsequently blown through an air-blast conveyor line of certain minimum specifications. Shavings produced by approved planers, or blown through an air-blast conveyor line of required dimensions, and properly identified, were similarly exempt. Lemon cuttings, used by the ornamental greenhouse trade, and a mineral product consisting of heat-treated vermiculite, used as a growing medium, were also added to the exempt products. Investigations were made of 352 apparent violations of the quarantine.

Among the products shipped in large quantities that were inspected and certified during the year were the following:

Logs, piles, posts, poles, ship knees, and ties	pieces	382, 137
Lumber	board feet	245, 062, 663
Shavings	bales	187, 935
Pulpwood	cords	28, 245
Cable reels	number	52, 461
Miscellaneous forest products	pieces	99, 213
Shrubs	number	2, 853, 604
Young trees	do	407, 064
Specimen evergreens	do	150, 616
Young evergreens	do	2, 275, 349
Seedlings and small plants	do	1, 056, 568
Boughs, balsam twigs, and mixed greens	boxes or bales	27, 124
Christmas trees	number	135, 281
Granite	pieces	31, 957
Paving blocks	number	35, 030

DUTCH ELM DISEASE ERADICATION

Modified by labor shortages and reductions in funds, the objectives of the Dutch elm disease control work under war conditions are fourfold. Most important is the scouting and eradication work carried on in a strip extending approximately 5 miles inside the boundary of the main disease area and from 10 to 15 miles outside. Year-round work is performed in this area in as thorough a manner as possible for the purpose of locating diseased and beetle-infested material. Supplementing these activities are exploratory surveys carried on in extensive territory from 30 to 40 miles beyond the border-zone strip. Another major objective is the continuance of eradication activities in isolated infected zones, remote from the main area. The only areas now considered as isolated zones are those surrounding Indianapolis, Ind., Athens, Ohio, and Cumberland, Md. The fourth objective involves a nominal amount of scouting in a few selected parts of the main disease area, in cooperation with the State involved, to determine

the amount of infection remaining in centers where eradication work was concentrated in years when more labor was available.

Scouting in the major part of the infected area has been discontinued. Whatever work is performed there is done by State, county, or municipal agencies.

Because of the gradual abandonment of Work Projects Administration operations, there were few sections in the main infected area where operations were comparable to those of previous years and in which comparisons could be drawn of progress in disease control. In Luzerne County, Pa., however, field work in general was fairly comparable to that of the previous season. Whereas in 1941 a total of 117 confirmations were reported in this country, only 67 infected elms had been discovered to the end of November 1942, when intensive scouting was discontinued. An encouraging reduction in the number of disease cases is indicated in this particular area.

SCOUTING FOR DISEASED OR BEETLE-INFESTED ELMS

Since 1933 the major part of the scouting has been performed by employees paid from emergency relief funds. At the beginning of this fiscal year 715 Work Projects Administration employees were engaged in the various phases of scouting and eradication, but the number was gradually reduced until at the end of January employment on emergency funds was terminated.

Whenever practicable, scouts were appointed for year-round work, and seasonal scouts were employed when local conditions warranted. The force of appointed employees was increased from 69 to 83 during the year. Seasonal workers numbered 129 at the beginning of the year, but only about 50 the following May and June. Included in this number was an all-woman crew of 4 employed in the Wilkes-Barre, Pa., area. These women learned to tie knots, handle ropes, and fell and burn trees, and all but 1 became proficient climbers. With this greatly reduced force only the most important activities could be undertaken.

A number of Bureau employees from other projects were assigned to Dutch elm disease work for the month of February. Those stationed in the regular work area took part in the established program. The others were assigned to special surveys outside the area of regular operations.

With the limited personnel available, scouting for diseased trees and bark beetle-infested elms was performed from July through September. Two surveys were completed in most of the border zone and the surrounding exploratory area, as well as in the three isolated areas and their surrounding territories. Toward the end of this period and on into October the selected portions of the main disease area were scouted. Later systematic scouting was done in the vicinity of a few nurseries containing large elm plantings. Exploratory scouting by autogiro was carried on in northeastern Ohio and western West Virginia late in July and early in August.

Eradication activities were combined with scouting from November to June. In areas of scattered elms diseased trees were removed as a part of the sampling work. In other sections as much infested and potential beetle material as practicable was destroyed at the time of scouting, but destruction of large amounts at a single location was deferred until the spring check-up.

To supplement the scouting program, systematic placing of elm logs as bark beetle traps was undertaken in May and June over the entire border zone and outlying territory. Rechecking of special problem areas and other phases of the work program were performed as the trapping progressed. The purpose of the trapping was to collect beetles for culturing rather than to reduce the elm bark beetle population. In some natural elm stands, lines of beetle traps were established to intercept any beetles that might be in flight from sections that were heavily infected in previous years.

First-record infections were reported from 44 towns, townships, and boroughs—9 in Connecticut, 1 in New Jersey, 7 in New York, 4 in Massachusetts, 17 in Pennsylvania, 5 in Ohio, and 1 in West Virginia.

Infections discovered in Massachusetts showed the disease to be much more widespread than had been disclosed by the single infection found last year at Alford. Three diseased trees were removed in Egremont and single infections were found in Great Barrington, Sheffield, and Westfield. With the exception of Westfield, which is in Hampden County, all these towns are in Berkshire County.

An infected tree was discovered in Old Lyme, New London County, Conn. Previously one case was reported from there in 1934, four in 1935, and one each in 1936 and 1937. The new location is only 200 feet from the site of the old infections.

Out of 12,735 samples submitted to the laboratory for culturing during the year, the fungus causing the disease was isolated from 1,368. Connecticut had 124 confirmations, New Jersey 851, New York 201, and Pennsylvania 167. The other 25 were from the isolated infected areas.

Since the disease was discovered in 1930, a total of 65,638 elms have been confirmed as infected. Segregated as to location, 1,904 have been found in Connecticut, 50,002 in New Jersey, 12,457 in New York, 1,013 in Pennsylvania, and 262 in the isolated areas. Some of the confirmations previously reported as occurring in the isolated areas have been included in the State totals.

ERADICATION AND SANITATION ACTIVITIES

Eradication and sanitation as activities separate from scouting were largely terminated with the release of Work Projects Administration workers engaged in this work. Removal of beetle-infested and potential beetle material, along with the eradication of diseased trees, kept up fairly well until November, when the heavy losses of personnel began.

In several sections of the work areas of Connecticut and Massachusetts elms were severely damaged by an ice storm late in December. In many places every tree had one or more broken branches. In limited sections the ice caused more damage to trees than did the hurricane of 1938. Heavy rains that occurred at the same time in other sections of the work area caused high water and floods that damaged elms along rivers and small streams. This extensive tree damage added large quantities of potential elm bark beetle material to be cleared up. In the main part of the disease area, where it was necessary to discontinue operations, cooperation in the control work was solicited from individual owners of elms, public utility companies, shade-tree commissions, railroad maintenance departments, and lumbermen. At the request of the Bureau, local authorities in Connecti-

cut and Massachusetts utilized some of the storm-damaged material as beetle traps. The Connecticut State Highway Department, 4–H Clubs, and Boy Scout troops in many of the sections affected by the ice storm were enlisted in the placing of trap piles and later destruction of the logs before beetle emergence. The State entomologist of Connecticut urged that eradication operations be undertaken by cities, towns, and individuals in the main disease area to lessen the possibility of serious damage from the disease in future years.

Crews engaged in tree removal destroyed 956 elms confirmed as infected, as well as 16,659 trees in the general elm-sanitation program. In the conservation work designed to save valuable specimen trees, 1,456 elms were pruned.

Since the eradication program was inaugurated in 1930, 4,515,676 elms have been removed by sanitation crews, 1,278,694 elms have been removed in operations to clean up areas difficult to scout, and 309,027 elms have been pruned to rid them of beetle-infested material and, in some instances, of localized infections.

Enforcement of the quarantine which prohibits the movement of elms and elm material from infected areas was continued.

WHITE PINE BLISTER RUST CONTROL

The war affected the progress of blister rust control work in several ways during the calendar year 1942. Within control areas there was a marked increase in white pine logging to meet the abnormal demands of war for this wood, and such cutting operations are usually followed by ribes and pine reproduction. This changes the status of control areas and adds cutover lands to those requiring ribes eradication for the protection of the new pine crop.

The armed forces took many trained and experienced workers. Emergency relief labor, which has been used extensively on this work in recent years, was not available in the western white pine and sugar pine regions, but in the eastern white pine region Bureau-sponsored State Work Projects Administration projects were carried on in several States. These projects were terminated either before or near the end of the year. The amount and quality of relief labor steadily diminished throughout the year, and its availability in different States and localities varied greatly; frequent revision of work plans was therefore necessary. The net result was a marked reduction in the amount of ribes eradication. The acreage of initial ribes eradication decreased more than half, but that of reeradication was only about one-sixth below the previous year, since more effort was directed toward maintaining control of the disease on protected areas.

ACCOMPLISHMENTS IN RIBES ERADICATION ON FOREST AREAS

Funds for cooperative control work were provided by States, counties, townships, timber protective associations, and lumber companies. This Bureau gave over-all leadership and technical direction to the control work of the cooperating agencies, and coordinated the ribes-eradication activities into effective work programs. In addition, the Bureau cooperated with the affected States in the enforcement of blister rust quarantines and made available information on the spread of the rust and on the progress and status of control. The results of this cooperative work are summarized in table 1.

TABLE 1.—*Ribes eradication work of all cooperating Federal, State, and local agencies for the calendar year 1942*

Region	Initial eradication	Reeradication	Total	Effective labor	Ribes bushes destroyed
	Acres	*Acres*	*Acres*	*Man-days*	*Number*
Northeastern States	149,076	339,538	488,614	32,551	3,169,027
Southern Appalachian States	102,780	94,761	197,541	9,238	906,407
North Central States	106,090	128,791	234,881	25,693	3,858,141
Western white pine states (Idaho, Montana, and Washington)	7,147	42,759	49,906	53,932	5,656,246
Sugar pine States (California and Oregon)	42,108	25,261	67,369	40,452	6,706,707
Total	407,201	631,110	1,038,311	161,926	20,296,528

In carrying out the field work 67 camps were operated in forest areas manned by temporary employees of the Department and cooperating agencies, mostly young men below draft age. The camps were distributed as follows: 43 in the western white pine region, 21 in the sugar pine region, and 3 in the north-central region. In addition 1 camp in the southern Appalachian States was manned with Work Projects Administration labor. In forest areas where camps were unnecessary the required seasonal labor was employed locally.

OTHER CONTROL ACTIVITIES

In addition to control work on forest lands, initial and reeradication work on 12,778 acres of protective zones around 33 nurseries resulted in the removal of 204,206 ribes bushes. These nurseries, which contained about 44 million white pines, were carefully protected to provide planting stock free from blister rust infection. In the North Central States 2,275 cultivated black currant bushes (*Ribes nigrum*) were destroyed in 367 locations. These plants are very susceptible to blister rust and important agents in the long-distance spread and local establishment of the disease. Their eradication supplements the application of control measures in white pine regions. Blister rust cankers were removed from 34,405 planted and ornamental pines. In addition 11,738 fatally diseased trees were destroyed. Control areas totaling over 911,000 acres were examined and mapped for ribes eradication.

SPREAD OF BLISTER RUST

No important extension of the infected area occurred in 1942. Scouting in the southern Appalachian region in northern Tennessee and North Carolina, where the rust was found on ribes for the first time the previous year, failed to show any signs of the disease. In Virginia blister rust was reported on white pine for the first time in Alleghany County, on white pine and ribes in Montgomery and Roanoke Counties, and on ribes only in Amherst and Craig Counties.

In the North Central States the rust continued to spread in unprotected areas, particularly in the northern part of Minnesota, Wisconsin, and Michigan. During 1937 and each year since then, rainfall has been abundant during the summer months, and widespread infection has appeared on both host plants, especially in northeastern Minnesota. Infected white pines were found for the first time in

Gogebic, Ionia, and Oscoda Counties, Mich.; Marquette County, Wis.; and Koochiching County, Minn. Infection on ribes was reported for the first time in Douglas County, Minn.; and in Benton, Boone, Bremer, Buchanan, Cedar, Franklin, Iowa, Marshall, Osceola, Winneshiek, and Wright Counties, Iowa. These findings in Iowa extend the known area of ribes infection to the west and south.

There was no long-distance spread of the rust in the sugar pine section of Oregon and California during 1942. Weather conditions were generally unfavorable and, except for one location at Brush Creek, Mendocino County, Calif., the disease was found on ribes only in the vicinity of sporulating cankers. The infected ribes bushes at Brush Creek were probably due to overwintering of the rust near the coast. This location extended the infected area in the Coast Range 10 miles farther south, or about 210 miles south of the Oregon-California line. Additional evidence of blister rust overwintering on ribes was obtained from an area near the coast in southern Humboldt County, Calif.

Within the infected part of the control area, favorable localities for the occurrence of blister rust were scouted and old infection centers reexamined. Several small centers of infection were found for the first time on sugar pines. The ribes were eradicated in the vicinity and the cankers removed from the infected pines to delay the spread and local intensification of the rust. This work resulted in the removal of 20,903 cankers from 2,675 diseased trees. Most of these pine infection centers occurred in an altitudinal belt between 3,750 and 4,250 feet elevation. *Ribes bracteosum* apparently caused more cankers and spread the disease a greater distance than other species. In one location on the Rogue River National Forest it was found that, of 6 *Ribes* species present, including the highly susceptible *R. bracteosum* and *R. cruentum*, the most heavily infected was *R. triste*. This was true both for the percentage of diseased bushes and for the area of leaf surface infected. Also in this forest *R. erythrocarpum* was found infected for the first time under natural conditions.

IMPROVEMENT IN CONTROL METHODS

Improvement in control methods through development and testing of equipment, crew formations, and chemicals, and through field study of the ecology of ribes and white pine, was continued in the western white pine and the sugar pine regions. In preliminary tests aqueous ammonium sulfamate showed promise as an effective herbicide on *Ribes roezli*. A portable preheating-type burning torch was tested and successfully used for killing ribes crowns located in rock crevices. Chemicals were tested for enhancing the typical bark discoloration produced by the fungus around incipient cankers on white pine, and color tests were devised which are useful in differentiating between diseased and healthy white pine tissue. Chemical tests and gross morphologic characters were established to aid field men in identifying underground parts of ribes capable of sprouting. Large-scale field tests showed some advantage in using special crew formations for working areas with few ribes bushes.

Further progress was made in the development of a ribes-regeneration key, which is intended to facilitate the classification of control areas so that the hazard of ribes regeneration may be predicted. In

California soils of low moisture equivalent and low carbon-nitrogen ratio were found to be poor ribes sites. Further data on the effects of logging, burning, grazing, and other disturbances on the regeneration of ribes and white pine were obtained from permanent study areas.

WHITE-FRINGED BEETLE CONTROL AND ERADICATION

Federal-State surveys to determine additional areas infested with the white-fringed beetle were conducted during the year at all maritime ports of entry from Corpus Christi, Tex., to Philadelphia and in many interior areas in the Gulf and South Atlantic Coast States. In 1942 infestations of economic importance were discovered in three North Carolina counties and in several localities near known infestations in other States. The Federal quarantine was therefore extended to include these areas. In 1943 major infestations were located in four additional North Carolina counties and in localities near known infestations in Alabama and Mississippi.

The control program of 1942 in Alabama, Florida, Louisiana, and Mississippi was aimed toward (1) prevention of dissemination of beetles by drastic suppression of populations and by regulatory measures; (2) drastic suppression aimed at eradication of isolated infestations; and (3) protection of crops by furnishing materials and equipment to farmers. In areas where drastic control measures were conducted in 1942, the larval population remained low the following spring. In some areas not so treated serious damage was caused to vital crops, and a Federal-State program of intensive suppressive measures was extended to all cultivated areas to protect important food, fiber, and oil crops from damage by adult beetles in 1943 and by larvae in 1944.

The control work has been benefited by improvements in spray machinery and nursery barriers, and by the development of an airplane hopper for insecticide distribution. The research divisions have developed more efficient methods of fumigation, assisted in formulating cultural and cropping practices not conducive to beetle abundance, and conducted studies of parasitic nematodes that offer possibilities in the field of biological control.

In revisions of the white-fringed beetle quarantine and administrative instructions, provision was made to facilitate movement of regulated products with minimum interference to commerce and maximum protection against pest dissemination.

GRASSHOPPER AND MORMON CRICKET CONTROL

States, counties, and other Federal agencies, including the Office of Indian Affairs and the Grazing Service of the Department of the Interior and the Forest Service of the Department of Agriculture, contributed substantially to the grasshopper and Mormon cricket control program this year. Agreements were worked out well in advance of the control season, personnel assignments made, control materials purchased, and other arrangements made to meet emergencies as they developed. With this advance planning, materials were on hand at the right time and in the right places, with few exceptions, even though market conditions were not always favorable and transportation facilities were frequently crowded.

Wet, cool weather during the spring and early summer materially reduced grasshopper populations in many areas where the survey had indicated that difficulties might be encountered. In many areas substantial populations existed, but crops that normally would have been susceptible to attack had a good growing start, and the movement of grasshoppers into crops was retarded by a succulent growth of natural vegetation on idle lands. High wages and the scarcity of farm labor combined to discourage voluntary control work until grasshoppers threatened extensive damage. Control operations embracing large areas of the public domain were conducted by the Bureau to minimize damage to ranges and to protect adjacent crop lands. In these areas airplanes rented under contract distributed 161 tons of wet bait over 16,100 acres of range land. Three Bureau-owned aircraft served on the same operations and spread 149 tons of wet bait on 14,900 acres. In addition, substantial quantities of bait were spread by individuals to protect Victory Gardens.

The cumulative effect of control operations and natural factors during the last 5 years has been a reduction in the area infested with Mormon crickets from 18,919,340 acres in 1939 to 2,026,920 acres in 1943. Unforeseen circumstances, arising largely from the fact that crickets invaded crop areas from unknown reservoir locations, made some expansion of control work necessary. Five hundred and twenty-two tons of bait (dry basis) were spread by two contract airplanes, and 417 tons by three Bureau planes; substantial acreages were baited by ground-spreader equipment; and a much smaller, though highly important, portion of the area, inaccessible to mechanical spreaders, was baited by hand. The combined operations resulted in the baiting of approximately 427,000 acres, instead of the expected 253,000 acres. Important savings of range forage and of adjacent crops were effected.

CONTROL OF CHINCH BUGS AND ARMYWORMS

Although ample barrier materials, both creosote oil and dinitro-orthocresol dust, were on hand in strategic locations, weather developments reduced chinch bug populations so that only limited Federal assistance was required in their control.

Outbreaks of bait-controllable armyworms promoted flurries of control interest in a few widely scattered areas. Users were promptly supplied with bait materials, and Bureau supervision was ample to insure their effective use, except where local outbreaks arose and subsided so quickly that damage occurred before materials and supervision could be provided.

BARBERRY ERADICATION

Wheat, oats, barley, and rye are grown on 75 million acres in the 17 States of the barberry-eradication area, and the annual production averages 1½ billion bushels, valued at more than $800,000,000. The eradication of barberry bushes and the development of new and improved varieties of grain during the last 15 years have contributed substantially to the present war effort by reducing stem rust losses approximately 50 percent. The 310 million barberry bushes destroyed during this period, and millions of their progeny, would today con-

stitute a serious hazard to the Nation's food program if they had been allowed to remain widely distributed throughout the important small-grain-producing areas of the country.

ACCOMPLISHMENTS IN 1942

Eradication work was conducted during the calendar year 1942 in areas aggregating 23,579 square miles in 17 States, and 15,240,787 barberry bushes were destroyed on 2,576 properties. In addition, 4,943 properties previously cleared were checked for regrowth and seedlings.

The field work was financed largely with Work Projects Administration funds, administered as Bureau-sponsored projects in 16 States. However, as the demand for men by the armed forces and the war industries increased, the total employment on the project was reduced to a low level, the number of men ranging from a high of 1,831 in March to a low of 182 in December. State programs were reduced accordingly, and in some areas where work was urgently needed men were not always available.

A summary of eradication work by States is shown in table 2.

TABLE 2.—*Accomplishments in barberry eradication, calendar year 1942*

State	Area surveyed	Properties cleared		Bushes destroyed		Salt used
		New	Old	*Berberis vulgaris*	Native species	
	Square miles	*Number*	*Number*	*Number*	*Number*	*Tons*
Colorado	354	17	119	1,725	1,464,418	0.4
Illinois	1,751	45	71	812		2.2
Indiana	1,607	39	11	255		.5
Iowa	1,819	162	115	9,926		15.0
Michigan	4,352	127	106	2,728		14.6
Minnesota	3,230	54	70	2,161		9.1
Montana	52	17	12	159		.3
Nebraska	1,063	11	21	125		.1
North Dakota	3,457	2	3	62		.2
Ohio	550	15	31	1,740		2.6
South Dakota	367	2	5	27		.2
Wisconsin	1,787	128	176	19,137		16.6
Wyoming						
Total	20,389	619	740	38,857	1,464,418	61.8
Missouri	2,167	35	7	269		.4
Pennsylvania	880	322	615	426,195		155.3
Virginia	128	179	11	3	4,884,435	314.1
West Virginia	15	18	30	0	8,426,610	317.4
Total	3,190	554	663	426,467	13,311,045	787.2
Grand total	23,579	1,173	1,403	465,324	14,775,463	849.0

SPREAD OF STEM RUST

There was less stem rust in 1942 than in any previous year since control measures were begun. Damage from the disease was negligible except in certain localities in west-central Missouri and in the barberry-infested areas of Virginia and West Virginia, where average losses ranged from 5 to 10 percent. Weather conditions were favorable for stem rust development, as evidenced by the widespread prevalence and severity of leaf rust of wheat, crown rust of oats, and flax rust, all of which became epidemic in some areas.

The light stem rust infection throughout most of the control area is attributed largely to the absence of inoculum from barberry bushes

and from overwintering centers in the southern States of the Wheat Belt. Several factors were responsible for this condition. There was less rust in northern Mexico, there were few overwintering centers in Texas, and the number of barberry bushes, which serve as early important sources of stem rust in the northern grain-producing States, has been greatly reduced by persistent eradication effort.

DISTRIBUTION OF PHYSIOLOGIC RACES

After having been surpassed in 1941 by race 17, race 56 again was the most prevalent in 1942. It was followed closely by races 17 and 38, which were about equally common. There is good evidence that race 38 spread westward from barberry-infested areas in Virginia, West Virginia, and Pennsylvania to Ohio, Indiana, southern Michigan, and parts of Illinois. In 1942 the ratio of races to the number of isolations from grain collections was 1 to 84, whereas it was 1 to 4 for collections of the aecial stage from barberry. This would indicate that, if susceptible barberry bushes are eliminated, there will be a substantial reduction in the number of races of the fungus present in grain-growing areas. In the experimental plots at St. Paul, Minn., resistant varieties of wheat such as Thatcher, Rival, Hope, and even *Triticum timopheevi* became rather heavily infected when inoculated under controlled conditions with several parasitic races, including 15b. This particular race has frequently been isolated from barberry in recent years, but it is not widely distributed away from barberry.

Races 2 and 5 of oat-stem rust comprised nearly 98 percent of the 228 isolations made during 1942. Four isolates of race 10 were obtained, 2 each from Ohio and southern Texas. One isolate of race 8 was made from a South Dakota collection. Races 8 and 10 can attack some of the new approved varieties of oats that are resistant to the more prevalent races of oat-stem rust.

The results obtained in 1942 provide further evidence that northern Mexico and Texas may be considered as one area in the epidemiology of wheat-stem rust. Southern Mexico, on the other hand, appears to have little influence on the spread of the rust in northern Mexico and the United States, although in 1942 races 17 and 56 were present in small quantities near Ixmiquilpan, which is about 100 miles north of Mexico City.

INSPECTION OF BARBERRY NURSERY STOCK

The inspection of nursery stock has resulted in almost complete elimination of susceptible barberry bushes from nurseries within the States participating in control work. Twenty of the approximately 80 nurseries, largely outside of the eradication area, that have in recent years listed from one to several susceptible species in their catalogs have now eliminated all susceptible stock. Applications were received from 72 nurseries for permits to ship immune species of *Berberis* and *Mahonia* into States protected by the quarantine. Sixty-one permits were granted, 10 were refused because susceptible bushes were found on their properties, and 1 did not need a permit because it was growing only the immune species *B. thunbergii*, which is not restricted by the quarantines. A total of 6,856 susceptible plants were destroyed in nurseries during the season.

BARBERRY IDENTIFICATION AND SUSCEPTIBILITY TESTS

Approximately 120 *Berberis* and *Mahonia* plants were received for identification. Fifty-two were identified for the Arnold Arboretum collection and included in its herbarium. The others were questionable species sent in by field men engaged in barberry eradication and were identified as a precaution against the destruction of immune plants.

The tests made at St. Paul, Minn., in 1942 warranted no changes in the susceptibility classification of barberry species, but data obtained at Bell, Md., resulted in the removal of *Berberis dictyophylla* var. *albicaulis* and *B. aemulans* from the immune list.

STATUS OF BARBERRY ERADICATION

The area designated for barberry eradication in the 17 States of the control area comprises 1,005,825 square miles. Initial surveys have been completed on 658,774 square miles, and this territory will require only a limited amount of maintenance work in the future, while the remaining 347,051 square miles will require one or more intensive surveys. Barberry bushes have been destroyed on a total of 127,527 properties, and of this number 40,592 will need no further work. Work on many of the remaining 86,935 properties will be completed after one more inspection.

SWEETPOTATO WEEVIL CONTROL MEANS MORE FOOD

Sweetpotato weevils have apparently been eliminated from 22 counties in Alabama, Mississippi, Georgia, and Texas by the work of the Bureau, the States, and the growers, and quarantine restrictions have been lifted. The results have contributed to the call for increased sweetpotato acreages this year. The adoption of dehydration by a large number of processing plants placed sweetpotatoes high on the list of foods demanded for the armed forces. The weevil-eradication work was extended in 1943 to 3 more counties in these States and to 8 Louisiana parishes contiguous to cleaned counties in other States. Fumigation of sweetpotatoes and the plants by methods developed by Bureau workers permitted their transportation from regulated areas without danger of spreading weevils and increased the sources of planting stock.

COST OF MOLE CRICKET CONTROL REDUCED

Operations against mole cricket damage on 34,429 acres of strawberry and vegetable plants were conducted in the summer and fall of 1942 in cooperation with the State Plant Board of Florida. The Bureau provided the supervision and technical assistance, and supplied the bait, which the State and county agencies transported and distributed. Sodium fluosilicate was used with the bran, since it has been found effective against both species of crickets, whereas calcium arsenate controls only one. The quantity of bait per acre was reduced without sacrifice of effectiveness. These factors reduced the control cost per acre 32 percent.

PINK BOLLWORM CONTROL AND QUARANTINE ENFORCEMENT

Inspection of the 1942 cotton crop in southern Texas and adjacent Mexico showed a considerable increase in pink bollworm infestation

as to density and area involved, including spread to Live Oak County, previously noninfested. There was some increase in pink bollworm population in the Big Bend, but it remained considerably lower than the peak of infestation reached in 1937. No infestation was found in the Panhandle. In other parts of western Texas and in New Mexico and Arizona infestation was much lighter than in 1941.

Eradication of wild cotton in Florida was greatly handicapped by shortage of funds and manpower, but progress toward final eradication was continued in the area closest to cultivated cotton.

COOPERATIVE WORK IN MEXICO EMPHASIZED

Work against the pink bollworm by the United States and Mexico has been carried on as a joint undertaking, but with no specific allocation of funds by this Bureau for operations in Mexico until this year. There was a heavy increase in infestation in the Mexican area adjacent to the lower Rio Grande Valley of Texas. Mexican farmers destroyed stalks on approximately 115,000 acres. A cooperative suppressive program was also in effect in the Ojinaga area of the Big Bend and in the Juarez Valley. Heavy infestations exist in the interior of Mexico, particularly in the Laguna section and near Delicias, in the States of Coahuila, Chihuahua, and Durango.

Since R. E. McDonald, as leader of the Division of Pink Bollworm and Thurberia Weevil Control, has long endeavored to promote cooperation between the two countries, it was believed that his knowledge of the pink bollworm suppressive work in the United States could be made even more useful if he were freed from Division leadership to seek better coordination of the efforts being put forth in the two countries. The matter was therefore discussed with Mr. McDonald, and he accepted an assignment in pink bollworm control in cooperation with the Department of Agriculture of Mexico, with headquarters at Torreon. L. F. Curl, formerly assistant leader, succeeds him as leader of that Division.

CONTROL PROGRAMS IN THE VARIOUS REGULATED AREAS

The increased infestation in southern Texas is attributed to excessive rainfall in 1941, which delayed field clean-up and provided late propagating material for overwintering larvae. Farmers destroyed stalks on 434,650 acres subsequent to harvest, leaving only a small acreage not completed on the date set by the Texas Department of Agriculture. The cooperative Federal and State program called for a host-free condition in that area until the fruiting of 1943 cotton, and sprouts were grubbed from 101,042 acres. By requiring permits to plant cotton in the lower Rio Grande Valley, the Texas Department of Agriculture had an opportunity to explain to each grower the importance of complying with specified measures. A total of 5,904 permits were granted, involving approximately 217,655 acres.

Floods in the Big Bend of Texas in September destroyed a good part of the cotton. All acreage was cleaned with the exception of fields in which plants were destroyed by the high water. Because of flood hazards in the fall, a program was adopted designed to shorten the growing season through early planting coupled with early clean-up of fields in the fall, rather than through delayed planting in the spring.

The cultural control program in effect in the Glendale area of Arizona called for plowing the land to a depth of 6 to 8 inches, fol-

lowed by irrigation. Changes in ownership of land and other factors prevented full compliance with this program.

ENFORCEMENT OF QUARANTINE REGULATIONS

A total of 1,001,080 bales of cotton were ginned at 533 gins in the regulated areas of Texas, New Mexico, and Arizona. In all, 402,635 tons of seed were sterilized, 387,568 tons of seed were received at the 48 designated oil mills, and 6,885 bales of linters from Mexico were fumigated. Fifteen compression plants handled 482,590 bales of lint and 2,143 bales of linters. In the supervision of these treatments 22,400 inspections were made.

In southern Texas about 1,900 small lots of seed cotton and cottonseed were intercepted through examination of 26,000 cotton-pick sacks being carried out of regulated areas.

INSPECTION

Gin-trash inspection in the regulated area in southern Texas showed a substantial increase in infestation. In Live Oak County, adjacent to that area, 2 pink bollworms were found through field inspection of bolls, representing the only spread of infestation since 1939. There was some increase in infestation in the Big Bend over the great reduction accomplished during the previous 3 seasons. In the Panhandle no infestation was found. In the New Mexico area the infestation was much lighter. In the vicinity of Glendale, Ariz., only 15 pink bollworms were found as compared with 701 the previous season. A total of 39,145 bushels of trash were examined in regulated areas, and 2,414 pink bollworms were found. Inspection of additional trash would have yielded many more specimens.

Outside the regulated areas inspections were made in 11 counties in Alabama, 9 in Arkansas, 6 in Florida, 45 in Georgia, 18 in Louisiana, 7 in Mississippi, and 71 in the nonregulated parts of Texas. In States other than Texas 5,838 bushels of trash were examined, and in Texas 23,264 bushels. Results of all this inspection were negative. Very satisfactory inspections were made in Mexico in cooperation with agricultural officials.

Summaries of the amounts and the results of the various kinds of inspection are given in tables 3 and 4.

TABLE 3.—*Summary of inspection for the pink bollworm in regulated areas, crop season of 1942*

State	Gin trash		Field [1]		Laboratory	
	Quantity	Pink bollworms	Blooms	Pink bollworms	Green bolls [2]	Pink bollworms
	Bushels	*Number*	*Number*	*Number*	*Number*	*Number*
Arizona	12,393	15	[3] 2,421	0	0	0
New Mexico	1,544	42	0	0	19,473	0
Texas	25,208	2,355	[4] 178,265	[5] 92	[6] 7,775	447
Total	39,145	2,412	180,686	92	27,248	447

[1] No squares or bolls were examined in the field.
[2] Bolls collected from 1941 cotton crop.
[3] From trap plots.
[4] In lower Rio Grande Valley.
[5] Distributed in counties as follows: Cameron 20, Brooks 56, Duval 1, Jim Wells 14, and Nueces 1.
[6] From El Paso and Hudspeth Counties, 438 and 9 specimens, respectively, being taken.

TABLE 4.—*Summary of inspections for the pink bollworm outside regulated areas, crop season of 1942*

State	Gin trash		Field		Field material
	Quantity	Pink bollworms	Labor	Pink bollworms	Squares
	Bushels	*Number*	*Man-days*	*Number*	*Number*
Alabama	673	0	0	0	0
Arkansas	552	0	0	0	0
Florida [1]	402	0	34½	0	3,950
Georgia	2,819	0	0	0	0
Louisiana	1,295	0	0	0	0
Mississippi	97	0	0	0	0
Texas	23,264	0	0	0	0
Total	29,102	0	34½	0	3,950
Mexico:					
Chihuahua	67	9,513	0	0	0
Nuevo Leon	669	0	0	0	0
Tamaulipas	842	17,841	0	0	0
Total	1,578	27,354	0	0	0
Grand total	30,681	27,354	34½	0	3,950

State	Field material			Laboratory [2]	
	Blooms	Bolls	Pink bollworms	Green bolls	Pink bollworms
	Number	*Number*	*Number*	*Number*	*Number*
Alabama	0	0	0	0	0
Arkansas	0	0	0	18,085	0
Florida [1]	1,830	28,075	[3] 60	42,975	0
Georgia	0	0	0	0	0
Louisiana	0	0	0	0	0
Mississippi	0	0	0	0	0
Texas	0	32,850	[4] 2	184,540	0
Total	1,830	60,925	62	245,600	0
Mexico:					
Chihuahua	0	600	26	0	0
Nuevo Leon	0	0	0	0	0
Tamaulipas	331,319	0	52	0	0
Total	331,319	600	78	0	0
Grand total	333,149	61,525	140	245,600	0

[1] The field inspection was of sea-island cotton, and the field material consisted of wild cotton.
[2] Bolls collected from 1941 cotton crop.
[3] From Monroe County.
[4] Taken through inspection of 15,500 bolls in Live Oak County.

WILD-COTTON ERADICATION

In previous years Bureau funds for the eradication of wild cotton in Florida were supplemented by Work Projects Administration allotments, and for two seasons the services of Civilian Conservation Corps enrollees were available. The loss of this cooperation in 1942–43 was felt to a considerable extent. For the period closing in June, 227,821 plants were destroyed, 40,368 being plants with mature bolls and 187,453 being seedlings. Of these totals 781 mature plants and 847 seedlings came from a few acres in sections located and cleaned for the first time. A decrease of more than 600,000 seedling plants

over the previous season is attributed largely to drought and incomplete coverage. A total of 16,102,328 plants have been destroyed since wild-cotton eradication was begun.

DOG FLIES CONTROLLED IN MILITARY ESTABLISHMENTS

Upon request of the Army Air Forces, and in cooperation with the Public Health Service, the Bureau conducted operations in the late summer and autumn of 1942 to control dog flies that threatened to suspend military activities along the Gulf Coast of Florida. Because the breeding places of the dog fly (stablefly) and the strategic time to spray had been determined by research workers, the control work was effective and military activities proceeded without interference. More than 600 miles of grass along a shore line of 922 miles was treated from sprayers mounted on small barges towed near the shore line. Investigators found that salt water was a satisfactory substitute for the Diesel oil previously used as a diluent for creosote.

TRANSIT INSPECTION

The greater demands for food production were reflected in increased interstate shipping of plants, particularly food and small-fruit plants, during the spring of 1943. Inspection of plant shipments in transit is designed to prevent transportation of pests destructive to agriculture and horticulture into uninfested regions. During the year transit inspection was conducted at 16 terminal and transfer points for mail, express, and freight, and 1,086,750 shipments were examined. A total of 1,286 apparent violations of 7 of the 9 Federal domestic plant quarantines were reported. This represented 1.18 violations per 1,000 shipments inspected as compared with 2.04 for the preceding year. Thirty-two violations of the plant-shipping regulations of the District of Columbia were reported, and 1,051 apparent violations of State quarantines, including those pertaining to phony peach and peach mosaic diseases and the sweetpotato weevil. Cooperation of State pest-control and transportation agencies was a considerable aid to the effectiveness of this activity.

TERMINAL INSPECTION OF MAIL SHIPMENTS

The States maintaining terminal inspection of mail shipments of plants and plant products under the procedure carried out in cooperation with the Post Office Department, which provides for turning back or disinfecting shipments if found infected, are Arizona, California, Florida, Idaho, Louisiana, Minnesota, Mississippi, Montana, Oklahoma, Oregon, Utah, and Washington. The District of Columbia, Hawaii, and Puerto Rico also maintain this procedure. The States that have availed themselves of the provisions of the terminal-inspection procedure for the enforcement of their plant quarantines are Arizona, Arkansas, California, Florida, Minnesota, Mississippi, Montana, and Oregon.

CONVICTIONS AND PENALTIES IMPOSED FOR VIOLATIONS OF THE PLANT QUARANTINE ACT

This year it was again unnecessary to resort to the courts in connection with any violation of the plant quarantines of the Department on the interstate movement of products. Even the minor violations by smugglers of Mexican plants and plant products along the southern border, which are disposed of directly by customs officials, were fewer than for a number of years past. Fines aggregating $284.25 were imposed by customs officials against 270 persons caught attempting to smuggle in prohibited plants and plant products from Mexico.

FOREIGN PLANT QUARANTINES

MARITIME PORT INSPECTION

The progress and development of the war during 1943 has directly affected the enforcement of foreign plant quarantines at maritime ports. Many of the effects noted in 1942 continued in 1943, and new problems developed. Since several experienced inspectors entered the armed forces or related war activities, personnel assignments had to be adjusted to meet the current, shifting needs at various ports. The submarine warfare caused fluctuations in the volume of ship arrivals in various areas. The arrival of convoys, usually without advance information, placed peak loads of work on the depleted staffs. In spite of this handicap, however, 98 percent of the ships arriving were inspected as compared with 92 percent in the previous year. The decrease in the number of inspectors from 75 to 65 was partially offset by a decrease of 1,905 in the number of inspections.

Because of the decrease in the number of cargoes requiring inspection, it was possible, despite the smaller staff, to give additional attention to problems arising from war conditions. Ship inspection was more difficult and costly in terms of inspector-hours because of wartime precautions exercised by other agencies to safeguard piers and docks and for other reasons of national security.

The use of dry ballast consisting in part of surface soil presented the problem of pest introduction, which is being solved through the cooperation of the authorities of the countries concerned. There has been improvement in the disposal of garbage under safeguards to prevent the escape of plant pests, but this problem is also accentuated by the convoy system.

Other complications due to the war included the discharge of cargoes at ports in areas where such landing is ordinarily not permitted (for example, unfumigated cotton lint in the cotton-growing area), the presence for considerable periods of hosts of fruitflies and other destructive insects, such as fruits held in ships' stores at ports in warmer areas, and the in-transit discharge, storage, and reloading of a commodity not permitted entry into the United States for sanitary reasons. Each such problem required modification of existing procedures and the adoption of emergency measures designed to give the maximum practical security against the possibility of pest escape with the minimum interference with the war effort.

The record of ship inspections appears in table 5. This table does not include ships engaged only in Great Lakes trade.

TABLE 5.—*Number of ships arriving, inspected, and bearing prohibited plant material, fiscal year 1943*

Origin	Arriving	Inspected	With prohibited material
	Number	*Number*	*Number*
Foreign ports, direct	15,748	15,612	4,043
Foreign ports, via United States ports	2,630	2,353	267
Foreign ports, via Hawaii	38	38	6
Foreign ports, via Puerto Rico	45	45	14
Hawaii, direct	757	757	111
Hawaii, via United States continental ports	41	41	0
Puerto Rico, direct	222	222	22
Puerto Rico, via United States continental ports	39	38	0
United States ports, via Panama Canal	76	76	10
Total	19,596	19,182	4,473

CARGO INSPECTION

Importations of plants and plant products were as follows: Fruits and vegetables, 8,281,461 containers, 20,599,529 bunches of bananas, 10,420,191 pounds, and 37 units; nursery stock and seeds, 11,600 containers, 356,843 pounds, and 2,629,776 units; cotton lint, bagging, and cotton products, 207,995 bales, 291,721 other containers, and 52,150,858 pounds; fibers and cereals, 712,781 bushels, 3,826 containers, 2,433 pounds, 11 units, 4,659 dozen, and 25,984 tons. In addition 338 lots of restricted plant material were admitted in accordance with the governing regulations at Canadian border ports, where no plant-quarantine inspectors are stationed, through the cooperation of the customs officers and the Canadian Department of Agriculture.

Although there was some falling off of cargo importations at maritime ports, this was largely offset by increased importations of many commodities, particularly vegetables, through Mexican border ports. As a consequence, the importations of fruits and vegetables approximated the quantity imported last year. The nursery stock, plants, and seeds entered in about the same volume as in 1942, but there were fewer importations of restricted fibers, cottonseed products, and cereals.

Also at the Mexican border ports there were several thousand importations of fruits and vegetables in such small quantities that no entries were required by customs, and no plant-quarantine record of them was kept; hence, they are not included in the figures given above. These small importations were inspected before being released, and their handling represented a large amount of work, especially at the larger ports.

DISINFECTION

The following plant material was treated under the supervision of inspectors and collaborators of this Bureau: 175,372 bales of bagging, broomcorn, cotton, cotton linters, etc.; 13,999,800 pounds of cottonseed cake and meal; 6,350 containers of acorns, chestnuts, plants, bulbs, and other miscellaneous restricted products; 3,395 samples of cotton lint, linters, etc.; 971,440 plants, cuttings, bulbs, roots, and other plant propagating units; and 20,464 pounds of seeds.

During the year representations were made by appropriate officials that long-staple cotton was urgently needed for manufacture into war

materials at mills in the Northeast, and arrangements were made for the prompt movement of this cotton directly from the piers to those mills, without vacuum fumigation, for manufacture there under plant-quarantine supervision and suitable safeguards in lieu of the required fumigation. This accounts in part for the reduction in the number of bales treated as compared with 1942. The volume of commodities treated other than cotton exceeded that in 1942.

AIRPLANE INSPECTION

The 13,093 airplanes from foreign countries which were inspected upon arrival at 23 ports of entry represented 4,440 more than the number inspected in 1942, an increase of 51 percent. Of these, 3,219 were found to carry prohibited plant material, much of which came from places where it is known to be the host of injurious pests. The fact that 25 percent of the airplanes inspected carried prohibited material is emphasized, as was the 16 percent in 1942, because it impels consideration of this rapidly developing avenue for pest introduction.

In connection with airplane inspection, 681 interceptions of insects and plant diseases were made. Most of these pests were found in plant material carried in baggage, cargo, mail, and stores, but some mosquitoes and other stowaways that might menace public health were included. Among the 48 interceptions of 33 plant-disease organisms found was 1 of sweet orange scab (*Elsinoë australis* Bit. and Jenk.), which disfigures citrus fruits in South America. Among the insects found were the citrus blackfly, Mexican fruitfly, West Indian fruitfly, Mediterranean fruitfly, pink bollworm, and a whitefly, *Dialeurodes kirkaldyi* (Kot.), attacking miscellaneous ornamentals.

FOREIGN PARCEL-POST INSPECTION

During the year 74,580 foreign parcel-post packages were inspected, approximately 10 percent less than in 1942. Of these, 476 were refused entry in whole or in part because of their content of prohibited plant material, 2,748 were diverted to another port for disposition, and 2,439 were released under permit. During the latter half of the year improved procedures for handling mail from personnel of the armed forces stationed abroad made possible the inspection of an increasing amount of parcel post from this source, some of which had previously been dispatched for delivery without reference for plant-quarantine examination.

MEXICAN BORDER SERVICE

A total of 69,184 freight cars from Mexico were inspected during the year, which represents an increase of 14,382, or 26 percent, over the number inspected during 1942. To safeguard against pest risk it was necessary to fumigate 12,142 freight cars as a condition of entry into the United States. Fumigation coupons at $4 each, valid for the fumigation of a freight car, were sold in the amount of $48,172. In addition 3,432 Pullman and passenger coaches entered the country and were inspected; also a total of 4,730,454 other vehicles and 558,559 pieces of baggage were examined through cooperation with the customs officials. The latter figures compare favorably with those for 1942 despite the present restrictions on the use of automobiles. The fewer Pullmans

and lesser amount of baggage inspected do indicate a reduction in tourist traffic.

INSPECTION IN PUERTO RICO AND HAWAII

In Puerto Rico no shipments of fruits and vegetables were inspected and certified for movement to the mainland under Quarantine 58, which governs such movement. The insular inspectors, acting as collaborators, assisted in the inspection of surface vessels and aircraft and in other plant-quarantine activities, all of which have been adjusted to meet the needs of the war. Protection against pest introduction via aircraft is one of the major problems, and the armed services are cooperating in affording this protection.

During the year there has been some resumption of the shipment of certified fruits and vegetables from Hawaii to the mainland under the provisions of Quarantine 13 governing such movement. The preflight inspection of commercial aircraft in Hawaii, together with the inspection of air express and baggage, is a feature of the enforcement of that quarantine, and the volume of this work was materially increased over 1942. In the inspection of parcel post for the mainland over a million pieces were handled. The inspection of express for the mainland also shows a marked increase over 1942. The inspection of mail and express was conducted in cooperation with the censors.

INSPECTION OF SPECIAL-PERMIT AND DEPARTMENTAL PLANT MATERIAL

A total of 484 shipments of incoming domestic material (consisting of 50,161 plants, cuttings, bulbs, etc., and 2,123 lots of seeds) and 1,710 shipments of outgoing domestic material (consisting of 144,501 plants, cuttings, bulbs, etc., and 6,512 lots of seeds) were inspected in the enforcement of the regulations governing the movement of plant material into and out of the District of Columbia. For the elimination of pests in these shipments 135,462 plants, 2,445 lots of seeds, and 228 parcels containing plant material not for propagation were given some form of treatment. In addition, 20,301 containers of plant material were examined at the post office, express office, and freight stations, and 9 truckloads containing 66,886 plants consigned to retail merchants in the District of Columbia were checked on arrival for proper certification.

INSPECTION OF PLANT-INTRODUCTION AND PROPAGATING GARDENS

Plant material that is being propagated at plant-introduction and propagating gardens maintained by the Bureau of Plant Industry, Soils, and Agricultural Engineering is inspected regularly for the presence of plant pests. Such material distributed from the gardens at Coconut Grove, Fla., and Mandan, N. Dak., was inspected by State officials cooperating with this Bureau. The inspections at Chico, Calif., were handled jointly by an inspector of this Bureau and an entomologist from the California Department of Agricuture. Material distributed from the District of Columbia, Maryland, and Savannah, Ga., stations was examined by inspectors of the Bureau. The following were examined prior to distribution from these stations during 1943: 300,275 plants, 8,927 bud sticks and cuttings, 96,528 roots and tubers, and 4,847 shipments of seeds.

INTERCEPTIONS OF PLANTS AND PLANT PRODUCTS

The numbers of interceptions of prohibited and restricted plant material for 1943 are shown in table 6.

TABLE 6.—*Number of interceptions of prohibited and restricted plants and plant products, fiscal year 1943*

Port	In baggage	In cargo	In mail	In quarters	In stores	Total
Baltimore	61	3	35	143	185	427
Blaine [1]	400	0	0	0	2	402
Boston	4	1	26	0	40	71
Brownsville	3,429	55	4	1,373	54	4,915
Buffalo [2]	231	1	5	0	0	237
Calexico	967	0	0	0	0	967
Charleston	12	1	1	13	33	60
Chicago	2	2	40	0	0	44
Corpus Christi	0	0	0	9	11	20
Del Rio	887	0	0	80	0	967
Detroit [3]	274	0	18	0	0	292
Douglas	1,215	5	0	168	0	1,388
Eagle Pass	2,053	0	1	0	0	2,054
El Paso	16,537	244	18	1,436	221	18,456
Fort Worth	25	6	0	46	26	103
Galveston	0	0	0	56	88	144
Hidalgo	3,752	0	0	646	0	4,398
Honolulu [4]	8	16	15	0	48	87
Houston	0	0	0	39	9	48
Jacksonville [4]	0	0	7	4	8	19
Key West [4]	1	0	0	1	5	7
Laredo	7,571	0	10	0	0	7,581
Miami [4]	1,591	30	2	302	1,712	3,637
Mobile	1	3	0	404	171	579
Naco	246	0	0	0	0	246
New Orleans	61	2	4	670	96	833
Newport News	3	0	0	1	58	62
New York	48	91	250	0	63	452
Nogales	2,907	2	4	11	7	2,931
Norfolk	9	1	0	154	73	237
Pensacola [4]	0	1	0	12	4	17
Philadelphia	65	11	59	55	382	572
Port Arthur	0	1	0	99	38	138
Port Everglades [4]	2	0	0	11	12	25
Portland, Oreg.	0	1	1	0	2	4
Presidio	244	0	0	0	0	244
Puerto Rico (all ports)	17	16	0	1	11	45
Roma	267	1	0	22	0	290
St. Albans	0	0	5	0	0	5
St. Paul	0	0	57	0	0	57
San Diego [4]	3	0	3	6	84	96
San Francisco [4]	102	0	17	80	263	462
San Pedro [4]	13	2	0	189	180	384
San Ysidro	1,981	0	0	0	0	1,981
Savannah	0	1	0	19	2	22
Seattle	24	3	14	1	0	42
Tampa [4]	1	2	0	92	98	193
Washington, D. C.	0	0	3	0	0	3
West Palm Beach [4]	0	0	0	5	11	16
Total	45,014	502	599	6,148	3,997	56,260

[1] Includes interceptions made at Anacortes and Bellingham.
[2] Includes interceptions made at Niagara Falls.
[3] Includes interceptions made at Port Huron.
[4] Collaborators stationed at these ports.

In addition to the interceptions shown in table 6, there were 728 interceptions of restricted and prohibited plant material in baggage by customs at Mexican border ports where no plant-quarantine inspectors are stationed. Customs officers at Canadian border ports without plant-quarantine inspectors made 446 such interceptions.

PESTS INTERCEPTED

During the inspection of foreign plants and plant products, and of such products received on the mainland from Hawaii and Puerto Rico, inspectors and collaborators of the Bureau collected insects be-

longing to 918 recognized species and others distributed among 667 genera and families, as well as fungi, bacteria, nematodes, and viruses belonging to 227 recognized species and large numbers of other pathogens that could be referred to genus, family, or general group only. Many of these interceptions were of important plant pests, others were of scientific interest, and a number were of undescribed species.

The combined total of 56,744 interceptions of insects and diseases made during the year were taken as follows (figures refer to number of interceptions): In material offered for entry for consumption, 36,100 insects, 15,160 diseases; in material offered for entry for propagation, 1,682 insects, 1,480 diseases; in material not offered for entry, such as in-transit shipments and materials in ships' stores, quarters, etc., 1,722 insects, 600 diseases; total, 39,504 insects, 17,240 diseases. In addition, inspectors stationed in Puerto Rico made 87 interceptions of insects and 44 interceptions of diseases during their field and packing-house inspection of fruits and vegetables for shipment.

CERTIFICATION FOR EXPORT

During the year 1,824 certificates covering 514,718 containers of plants and plant products were issued to meet the sanitary requirements of foreign countries. Export certificates were issued at 29 ports covering 42 commodities which were exported to 53 foreign countries. The arrangements made in 1941 continue to be available to the armed forces in meeting the sanitary requirements of the countries concerned in connection with the movement of supplies to leased defense bases outside the limits of the United States.

INSECT PEST SURVEY AND INFORMATION

Owing to curtailment of funds and personnel, little was added to the permanent files of the Insect Pest Survey other than current notes received from collaborators. The total augmentation amounted to 4,500 notes. The index on plants attacked by insects was increased by 175 genera and 600 species. Survey data on 150 subjects were furnished to the several divisions of the Bureau and outside agencies. The Insect Pest Survey Bulletin was discontinued early in 1942, but 3 regular supplements and 2 special supplements, Status of the European Corn Borer in 1942 and Estimates of Damage by European Corn Borer in 1942, were issued, and a summary of insect conditions appeared each month during the active season.

During the year informational material in the form of press releases and radio releases was issued on 194 occasions, and 25 prints of motion pictures were purchased for educational purposes.

A total of 331,000 printed publications of the Bureau were sent out. In addition, a number of processed publications to meet immediate needs, for the most part connected with the war, were distributed. A series of publications known as Insects in Relation to National Defense, prepared for a limited circulation, has proved so popular that the edition is practically exhausted.

EDITORIAL WORK AND PUBLICATIONS

At the beginning of the year 243 manuscripts were on hand, and during the year 404 were received, making a total of 647. Of these, 42 were withdrawn, 61 were published by the Department, 54 were issued in processed form by the Bureau, and 320 were approved for outside publication. On hand at the end of the year were 170 manuscripts, 135 of which were in the Bureau, 15 in the Office of Information, and 20 at the Government Printing Office. Of the 135 in the Bureau, 53 were being reviewed or edited for departmental publication and 82 for publication outside.

The Bureau's 61 Department publications included, in addition to the annual report of the Chief of the Bureau, 9 Circulars, 5 Farmers' Bulletins, 3 Leaflets, 5 Miscellaneous Publications, 8 Service and Regulatory Announcements, 2 Technical Bulletins, 1 Unnumbered Publication, 7 articles for the Journal of Agricultural Research, and 20 for other Government publications.

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